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Santa Clara Valley Water District

South Santa Clara County Historical Water Supply and Use Report

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Chapter 1. Introduction

Background

The southern area of Santa Clara County is bounded by the Diablo mountain range to the east, the Santa Cruz mountains to the west, and a long relatively narrow valley in between. The area extends from Metcalf Road in the north to the County line, the Pajaro River, in the south. The study area is that portion of south county defined as Water Zone W-5, which is roughly the valley floor and the lower slopes of the surrounding hills. Figure 1 shows the study area further divided into four subareas for planning purposes, the COYOTE, MORGNH, SMARTN, and GILROY water service areas (WSAs).

The cities of Morgan Hill and Gilroy, with populations of 28,000 and 36,000 respectively, are the major urban centers in the region. As a whole, southern Santa Clara County is more rural than the north, and historically the majority of the area has been agricultural. The region is urbanizing rapidly, however, changing the nature of the land use and the water requirements. In addition to the cities of Morgan Hill and Gilroy, much of the Coyote region is within the city of San Jose sphere of influence, and the San Martin area is developing as low density rural residential.

The study area includes two groundwater subbasins, the Coyote and Llagas Subbasins. The Coyote Subbasin extends from Metcalf Road south to Cochran Road, and drains into both the Llagas Subbasin and the Santa Clara Valley Subbasin (to the north). The Coyote Subbasin is approximately 7 miles long and 2 miles wide and has a surface area of approximately 15 square miles. The Llagas Subbasin extends from Cochran Road, near Morgan Hill, south to the county's southern boundary. It is connected to the Bolsa Subbasin of the Hollister Basin and is bounded on the south by the Pajaro River (the Santa Clara - San Benito County line). The Llagas Subbasin is approximately 15 miles long, 3 miles wide along its northern boundary, and 6 miles wide along the Pajaro River. The subbasin surface area is approximately 74 square miles.

Almost all the water supply in the region comes from the Coyote and Llagas groundwater subbasins. The natural groundwater supplies are augmented by recharge of local surface water and, starting in 1987, imported Central Valley Project (CVP) water. Estimates of the natural groundwater yield for the Coyote subbasin averages about 4,900 acre-feet/year, ranging from about 3,200 acre-feet/year in dry years to 10,000 acre-feet/year in wet years. For the Llagas subbasin, the estimated average natural groundwater yield is about 44,300 acre-feet/year, ranging from 29,100 to 89,000 acre-feet/year.

Purpose of Study

An accurate understanding of what has occurred in the past is an essential part of planning to meet future needs. Better information on the historical water use in south county is valuable for two reasons: first, estimating future water use requires knowing about the existing water use patterns, and second, the natural groundwater yield for different hydrologic conditions is typically estimated from past change in groundwater storage and groundwater pumping data. Change in groundwater storage information is available for south county, but groundwater pumping information is sparse.

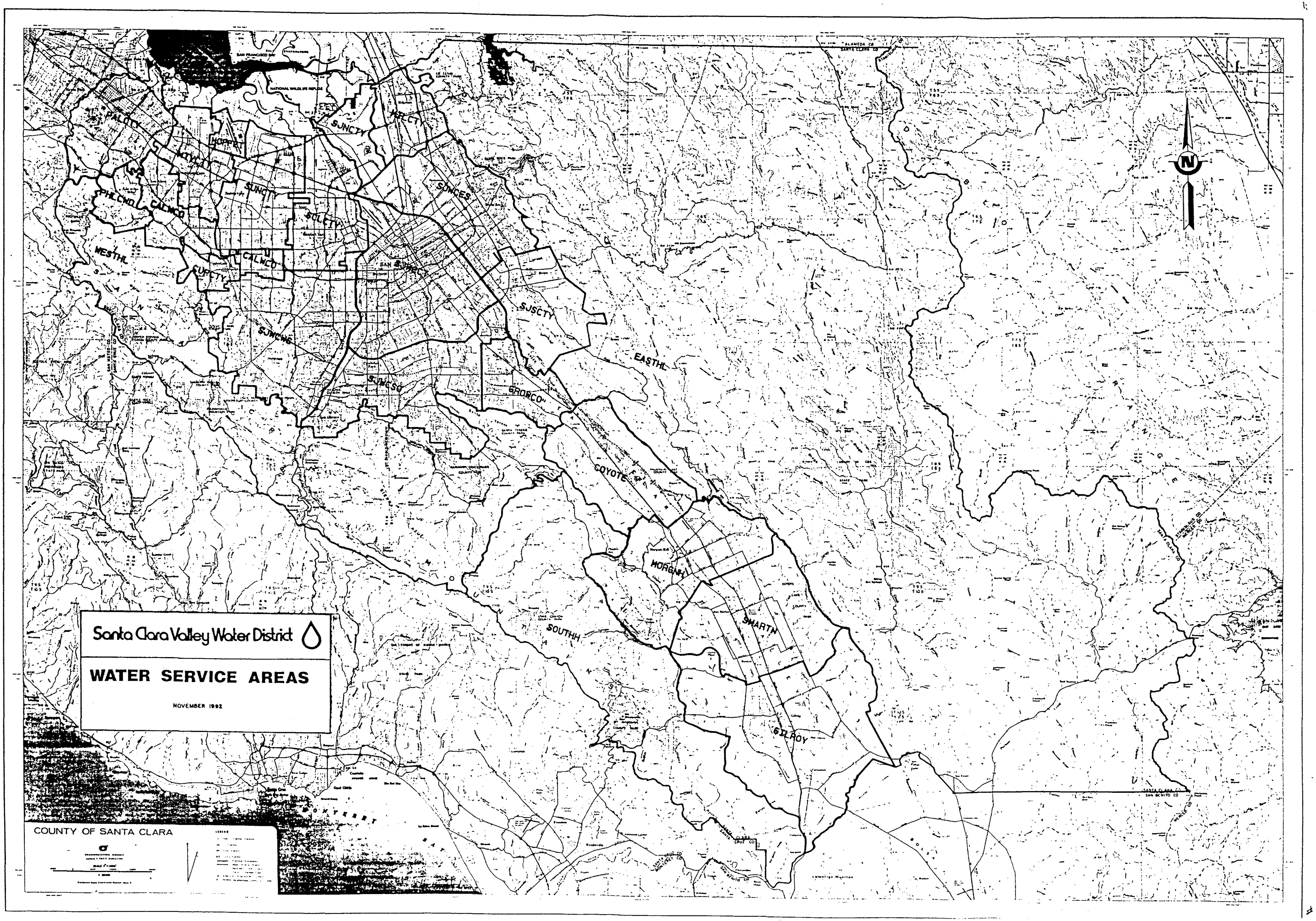
The majority of the water use in south county is supplied from independent pumping rather than water system deliveries. The cities of Morgan Hill and Gilroy operate municipal water systems that serve the majority of users within their boundaries. The agricultural water users, the water users outside the city boundaries of Morgan Hill and Gilroy, and many large users within the city boundaries get their water supply from their own groundwater wells. Data on the municipal water systems are available for the study period (1967 through 1990). However, the District did not begin recording water use information for south county until 1987, and information on independent groundwater pumping prior to that time is not available.

Previous Water Resources Studies

The major previous analyses of south Santa Clara County water use are summarized below. A matrix of the information sources and previous related reports investigated during this analysis is included in Appendix A.

Santa Clara County Flood Control and Water District South Santa Clara County Water Planning Study Final Report

This 1972 study evaluated the water needs of the south county area, from Hillsdale Avenue in the north to the Pajaro River in the south (including the Edenvale and Almaden areas). The study presented projected water demands from year 1970 through 2020, based on County Planning Department land use and population projections. Agricultural water use was projected using the DWR 1967 agricultural land use survey as a base acreage and average per acre water use coefficients for each of the WSAs. The average coefficient for each WSA was derived using crop acreage from the DWR survey and water use coefficients by crop used by the District to assess groundwater charges. The water use coefficients used are shown in Figure 2. The projected water use and populations for the Coyote, Morgan Hill, San Martin, and Gilroy WSAs are shown in Figure 3.



Santa Clara Valley Water District

WATER SERVICE AREAS

NOVEMBER 1992

The report states that the groundwater levels within the study area were considered to be in equilibrium at that time. In other words, the water supply was equal to the water demand. Therefore, the supplemental water needs were obtained by subtracting the total water demand in the year 1970 from the projected water demand for the year under consideration. The water supply in 1970 included natural groundwater yield, artificial groundwater recharge, and surface supplies.

Figure 2. Water Use Coefficients used in the 1972 South Plan

Sector	Per Acre Water Use Coefficient (acre-feet/acre/year, unless otherwise noted)
Agricultural - Coyote	1.57
Agricultural - Morgan Hill	1.3
Agricultural - San Martin	1.55
Agricultural - Gilroy	1.9
Commercial	4.0 in year 1970 growing to 5.0 for year 1990 and beyond
Industrial	7.25 in year 1970 decreasing to 5 in year 2020
Outdoor Residential	1.0
Indoor Residential	80 gpcd in year 1970 increasing to 95 gpcd by year 2000

Figure 3. 1972 South Plan Projections

	Year 1970	Year 1990 (low proj.)	Year 1990 (high proj.)	Year 2020 (low proj.)	Year 2020 (high proj.)
Population		85,434	126,491	126,491	296,567
Agricultural Use (AF)	69,085	63,254	58,650	58,638	38,178
M&I Use (AF)	6,249	21,698	33,279	33,985	81,996
Total Water Use (AF)	75,334	84,952	91,929	92,623	120,174

1975 Master Plan for Expansion of the In-County Water Distribution System

This report presented projected water demands through the year 2020 and alternatives for meeting those needs. The projections are broken down by groundwater basin for the decade years between 1980 and 2020. The supplemental water demand is defined as the shortfall of average annual supply compared to the projected water demand.

The demand projections were based on population, land use, and employment projections from the Santa Clara County planning department through the year 2000, extrapolated to year 2020. Three sets of population projections were presented, corresponding to different net annual inmigration rates. The low population projection was used in the Plan for determining supplemental water demand. For south county, the M&I water demand was computed using a per capita demand of 0.22 af/person/year.

The text of the report states that "irrigated acreage in the year 1970 in the Coyote and Llagas Basins were obtained using information from the 1965 land use survey of the county, the 1967 land use survey of the Department of Water Resources, and the increase in urban land between 1965 and 1970. For the south county agricultural projection, per acre water use coefficients were based on north county metered water use data, the assumption being that south county water use per acre of the same crop would be similar to that in north county when south county was subject to the same metering and pump tax provisions. The per acre water use was projected to increase in time as orchards were replaced by higher water use truck and row crops, from a current (at that time) coefficient of 1.5 af/acre/year to 2.25 af/acre/year in year 1990 and beyond. The population and water demand projections for the Coyote and Llagas subbasins are shown in Figure 4.

To determine the supplemental water need, the report compared the projected demands with estimates of the long term average water supply. The natural groundwater yield for south county was estimated as 64,300 acre-feet/year.

Figure 4. 1975 Master Plan South County Projections

	Year 1990	Year 2020
Population	84,600	234,550
Agricultural Use (af/year)	94,310	75,020
M & I Use (af/year)	20,100	51,000
Total Water Use (af/year)	114,410	126,020

Evaluation of Groundwater Resources South San Francisco Bay, Volume IV: South Santa Clara County Area (Department of Water Resources Bulletin 118-1)

This 1981 report describes the geohydrologic conditions in the South Santa Clara Valley and a contiguous portion of the Hollister Basin in San Benito County. The intent of the study was to provide a framework for the development of a groundwater model of the basin. The period of study was 1964 through 1973. Additional work would be required to separate out the pumpage in San Benito County from that in south Santa Clara County.

1983 South Santa Clara County Water Supply Plan
1980 Water Supply, Determination of Local Water Supply in Santa Clara County

The 1983 South Plan updated the section from the 1975 Master Plan that assessed the water demand and supplemental water requirements for south county in the year 2020. The demand analysis estimated the change in water use as individual parcels of vacant land converted to their ultimate use, where vacant parcels include all forms of agricultural land as well as land not in use. For each parcel, the acreage, current and expected ultimate use, and the date of conversion to ultimate use were identified. The projected demand is the sum of the base year water use (84,600 acre-feet for year 1975) plus the incremental changes due to land conversion. A range was projected using different residential densities and intensities of industrial use. The mid-range projection was used for water supply planning purposes because "this choice gives the District significant flexibility in responding to future patterns of growth in water needs". The projections are shown in Figure 5.

The details of the water supply assessment used in the South Plan are found in the 1980 Water Supply Staff Report. The historical natural groundwater yield was estimated using groundwater pumping, artificial recharge, and change in groundwater storage data. The long term average natural groundwater yield of south county was estimated to be 49,000 acre-feet/year.

Figure 5. 1983 South Plan Projections

Water Demand (af/year)	Year 1990	Year 2020
Agricultural Use	69,300	52,500
M & I Use	30,700	73,400
Total Water Use	100,000	125,900

1993 Water Needs Study

This report updated the long-term water demand projections for water supply planning. The demands were projected in four categories: (1) residential, subdivided into single-family and multi-family subcategories, (2) commercial/industrial, (3) unaccounted, and (4) agricultural. The projected number of households and jobs through year 2005 were obtained from the Association of Bay Area Government's *Projections 1990* and extended through year 2020 by the District with local planning agency input.

To project the south county agricultural water demand, first the base acreage for year 1990 was estimated using land cover maps developed by DWR and checked against aerial photographs of the area. Lands denoted as idle (meaning not cropped at the time of the DWR survey, but cropped sometime during the last three growing seasons) were included in the base acreage estimate. The conversion of agricultural land to other uses, as indicated by the general plans for the cities of San Jose, Gilroy, and Morgan Hill, was accounted for in the projections of future agricultural acreage. An average per-acre water use of 1.8 acre-feet per acre per year was used to project future water use, based on analysis of actual per-ace water use by crop for south county and the cropping patterns characteristic of south county.

Residential water use was projected for each water service area using equations taken from the U. S. Corps of Engineers IWR-MAIN forecasting model, calibrated for this county using local water use records. A commercial/industrial water use coefficient and a percentage estimate of unaccounted for water were developed, also from local water use records. These coefficients are shown in Figure 6. Water savings from changes in state law requiring the sale of water efficient shower heads and toilets and from District water conservation programs are not reflected in these coefficients. Anticipated water savings were estimated separately and are reflected in the water demand projections. The south county water demand projections are shown in Figure 7.

Figure 6. Water Use Coefficients used in the 1993 Water Needs Study

Sector	Per Acre Water Use Coefficient
Agricultural	1.8 acre-feet per acre per year
Single-family Residential	400 to 1100 gallons per day per unit (average of 560 gallons per day per unit)
Multi-family Residential	275 to 300 gallons per day per unit (average of 284 gallons per day per unit)
Commercial/Industrial	135 gallons per employee per day
Unaccounted for Water	7.7 percent of total water use

Figure 7. 1993 Water Needs Study South County Water Demand Projections

Water Demand (af/year)	Year 1990	Year 2020
Agricultural Use	60,813	41,810
M & I Use	18,772	59,501
Total Water Use	79,585	101,311

1994 Overview Study

The draft 1994 Water Supply Overview Study was the first study to assess the reliability of the District's water supplies during dry periods. The study identified the county's total supplemental water needs during the design drought, called the critical dry period, for the year 2020.

The water demand projections used in the Overview Study were taken from the Water Needs Study, described above. An operations model was used to determine the supplemental water needs under future demand levels assuming historical supplies. Staff developed estimates of south county historical water use in order to estimate natural groundwater yield for south county for the years 1967 through the present. Historical agricultural water use was computed using estimated annual irrigated acreage and composite crop factors for each year.

First, annual composite crop factors were computed for several hydrologicly diverse years, and a relationship between the annual crop factors and annual rainfall was developed. For select years, crop factors for each crop were developed by dividing the reported water production in north county by the crop's reported acreage; the result was the crop factor used for that crop for that year in south county. If data was available for a particular crop, then water revenue's crop factor was used. A weighted average crop factor was computed for the year.

The average crop factors computed for those select years were regressed against annual precipitation at the Gilroy rain gage. Crop factors for the years 1967 through 1989 were predicted using this regression relationship.

Then, crop acreage in south county were estimated by subtracting north county acreage (as reported to water revenue) from the county totals shown on the county crop reports. An attempt was made to adjust the estimates for crops known to be grown in the hills (outside both the W-2 boundary and the study area W-5).

Lastly, the estimated agricultural water use was determined using the crop factors and acreage described above. The groundwater pumping in south county was calculated as the sum of the estimated agricultural quantities and the municipal quantities reported by Morgan Hill and Gilroy. No provisions were made for rural domestic pumping or surface water diversion and use.

The natural groundwater yield in south county under average and critical dry period conditions was estimated as 49,200 and 32,300 acre-feet per year, respectively.

Overview of Report

This report summarizes the analysis performed in estimating south county water use and natural groundwater yield for the years 1967 through 1990. The layout of the report is as follows:

- Chapter 2 Agricultural Water Use
  - Irrigated Crops
  - Adjustments for Weather
  - Livestock
- Chapter 3 Non-Agricultural Water Use
  - City-Supplied Water
  - Major Independent Pumpers
  - Per Capita Estimates for Other Pumpers
- Chapter 4 Water Use and Water Supply
  - Natural Groundwater Yield Computation
  - Conclusions

Appendices

Chapter 2. Agricultural Water Use

Although agriculture has been declining in south county in past years, the majority of water use in the region remains agricultural use. Agricultural water use can be broken down into two main components, irrigated crop use and livestock use. Irrigated crop use is by far the majority of the agricultural water use in south Santa Clara County.

Irrigated Crop Water Use

Estimation Method Alternatives

Given the shortage of directly measured water use data, there are two main approaches that can be used to estimate agricultural water use: estimation of consumptive water use using crop data and estimation of groundwater pumping using power consumption data.

Consumptive Use Method

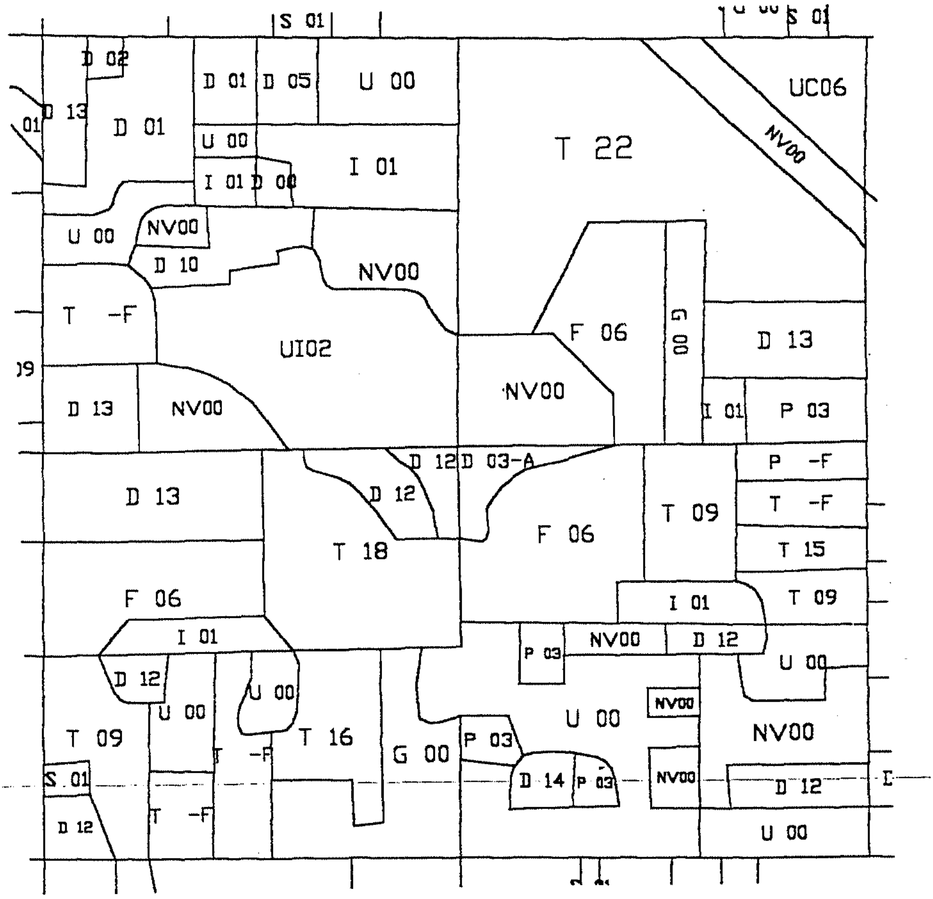
The consumptive use method uses data on crop production or crop acreage and knowledge of crop water needs per acre to estimate crop water use. A variety of sources tabulate crop water needs per acre. The larger data requirement with this method is detailed crop acreage data for each year in the study period.

There are two main sources of crop acreage data for south county: land use surveys from the California Department of Water Resources (DWR) and the annual Santa Clara County Agricultural Crop Report (commonly referred to as the County Crop Report), produced by the County Department of Agriculture. Although other agencies perform land use surveys, such as the county planning department, these surveys do not break down agricultural land use by crop and thus are not useable for consumptive use estimation since different crops have different consumptive water needs.

Detailed land use surveys are available from DWR for the years 1967, 1977, and 1990. These surveys are probably the most detailed and most reliable data source for agricultural land use. First, DWR delineates field boundaries, using aerial photography, on U. S. G. S. 7½ minute quad maps. Then, field surveys are performed to determine the land use by delineated area. Figure 8 shows an example of DWR's land use survey maps.

Land Use Survey Program

Since 1950, DWR has conducted detailed land use surveys as part of its Land Resource and Use Program. These surveys are used in determining urban and agricultural water needs. Every major water using county is resurveyed approximately every seven years. The base maps used for all DWR land use surveys are U.S. Geological Survey 7–1/2–minute–quadrangle maps, scale 1:24,000 acres. Land boundaries are delineated using low and high elevation aerial photography. These maps are taken to the field to make positive land use identification and to verify those interpreted from the photographs. In addition, crop acreage information from county agricultural commissioners and farm advisors is used to help determine the extent of double cropping. The acreage of each crop type (and other land uses) are determined and summarized by quad, county, irrigation district, and hydrologic area. The present method used to generate the maps and process the resulting data is computer digitization of land use boundaries as well as subsequent data analysis within a geographic information system. The figure below is an example of map output from this process.



Enlarged section of Brentwood quad from 1991 Delta survey

The County Crop Reports summarize the county-wide harvested acreage, tons per acre, and value by approximately 60 separate crops. County Crop Reports are available for every year in our study period, but only county totals are given and they are not considered as accurate as the DWR land use surveys since they rely on self-reported acreage information rather than actual aerial surveys and field inspections.

Power Consumption Method

Power methods use power billing data for agricultural wells to estimate groundwater pumping. The efficiency lift method uses total power consumption, average pumping efficiency, and average pumping lift to estimate the amount of groundwater pumped. The unit power consumption method is less accurate than the efficiency lift method, but it can be used when lift head data is not available. Unit power consumption is defined as the number of kilowatt hours required to pump an acre-foot of water during a plant-efficiency test. This method requires total power consumption and an average of unit power consumption. Power consumption data is not readily available; power company data is protected by customer confidentiality provisions.

Method Selected

Given that crop acreage data is available and that power consumption data is not, we chose the consumptive use method for estimating agricultural water use. The acreage and water use coefficients used are described later in this chapter.

Crop Grouping

Dozens of crops are grown in south Santa Clara County. Rather than estimate each crop separately, crops were grouped into similar categories based on water use and compatibility with the groupings used by DWR in their land use surveys. Only a few of the most important crops (either because of high water use or large acreage) were tracked separately. The major groupings used in this study were:

- fruit/nut trees,
- grapes,
- corn,
- cucumber/squash/melons,
- garlic,
- peppers,
- tomatoes,
- other vegetables/truck crops,
- hay-alfalfa,
- other grains/hay,
- sugar beets,
- irrigated pasture,

- other field crops, and
- flowers.

The list of crops combined in each of these major groups can be found in Appendix B.

Acreage Determination

As mentioned above, there are two major sources of crop acreage data available: DWR land use surveys for 1967, 1977, and 1990, and the annual County crop reports.

DWR Land Use Survey Years: 1967, 1977, 1990

Because of their high accuracy and level of spatial breakdown, DWR land use survey data were used when available. The acreage by crop was determined by District WSA as described in Appendix C. Appendix D tabulates the acreage by crop by WSA as determined from the DWR maps. The irrigated acreage for the county as a whole from both the county crop report and the DWR land use survey are tabulated in Figure 9.

Figure 9. Irrigated Acreage for Santa Clara County

CROP TYPE	Year 1967		Year 1978		Year 1990	
	DWR Survey	County Crop	DWR Survey	County Crop	DWR Survey	County Crop
DECIDUOUS (and KIWI)	49,577	47,040	12,618	11,039	4,809	3,914
GRAPES (ALL)	2,703	3,138	1,772	2,072	964	1,550
CORN	699	595	125	120	1,662	1,100
CUCUMBERS/SQUASH/MELONS	1,384	1,995	1,635	1,170	946	1,235
GARLIC	764	320	1,051	590	1,159	475
PEPPERS	1,364	1,375	1,561	1,550	1,738	1,760
TOMATOES	9,115	8,680	6,593	5,600	2,899	2,150
Other vegetable/truck	5,898	4,703	8,546	4,254	3,281	4,344
HAY-ALFALFA	464	750	508	250	514	800
Other grain & hay	32	14,700	3,617	6,970	6,919	19,300
SUGAR BEETS	285	305	605	615	793	826
PASTURE-IRRIGATED	3,403	1,600	1,975	1,500	1,175	2,500
Other field crops	176	1,050	1,269	1,310	1,146	2,900
TOTAL FLOWERS & NURSERY	697	800	645	1,362	1,638	1,564
Totals	76,561	87,051	42,520	38,402	29,643	44,418

Acreage for Other Years

No source comparable to the DWR land use surveys was available for other years. Acreage for those years were estimated using the county crop reports and information from the DWR land use surveys. Given the limitations of the data sources available, we chose to estimate crop

Figure 10. Estimated South County Irrigated Acreages

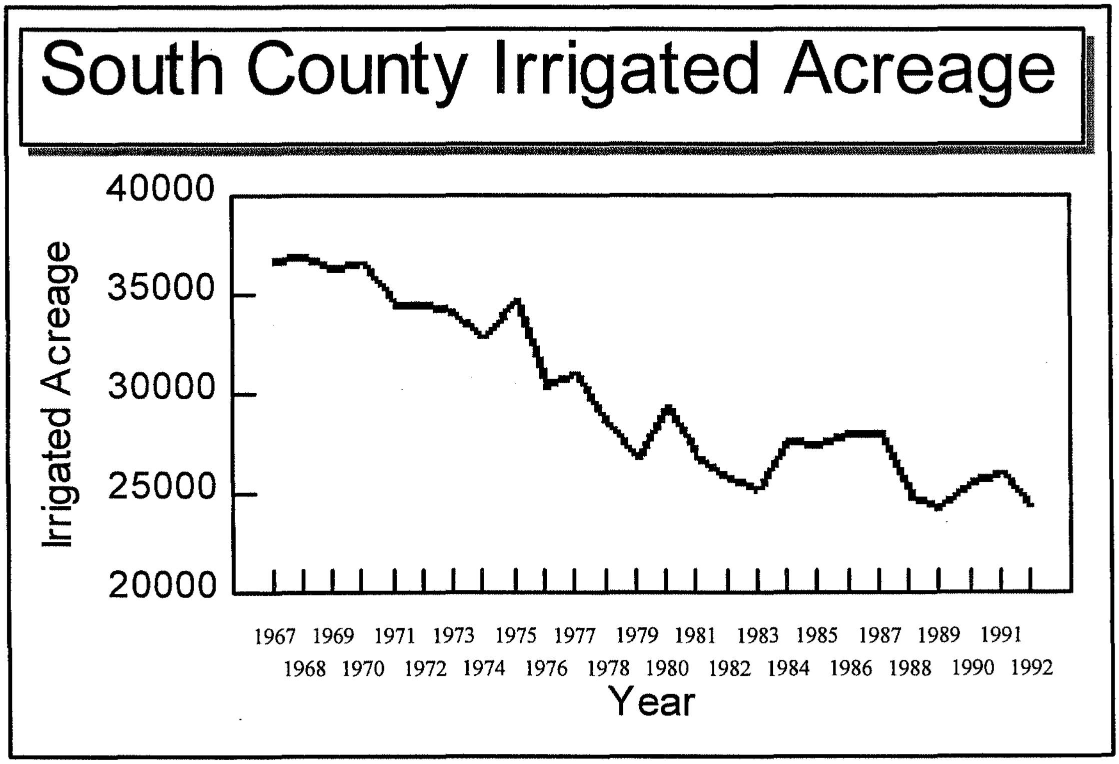
CROP TYPE	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Fruits and Nuts	21,016	20,650	19,656	18,419	15,989	14,638	13,125	11,744	10,673	8,170	7,935	7,126	6,791
Grapes	1,857	1,658	1,541	1,592	1,512	1,613	1,433	1,410	1,376	1,270	1,288	1,220	1,184
Corn	630	381	739	422	495	368	252	173	251	272	151	125	192
Cucumbers/Squash/Melons	1,157	1,046	1,334	1,306	1,328	1,463	1,330	1,165	1,488	1,934	1,714	1,525	1,096
Garlic	509	965	926	1,183	1,245	1,073	1,068	719	865	1,135	829	1,051	954
Peppers	1,280	1,461	1,320	1,078	1,263	1,420	1,326	1,381	1,088	1,111	1,526	1,433	1,721
Tomatoes	4,868	5,399	4,227	5,402	4,980	5,596	6,278	7,566	8,501	7,523	8,309	6,385	5,923
Other veggie/truck	2,188	1,933	2,640	2,377	1,905	2,062	2,360	2,252	2,618	3,038	2,694	3,016	3,187
Hay-Alfalfa	358	273	406	372	378	472	1,000	323	324	405	532	440	415
Other grain & hay	0	382	811	1,026	1,637	1,990	2,388	2,119	2,702	994	2,428	2,149	1,328
Sugar Beets	244	323	261	700	1,196	1,330	666	390	1,648	1,658	1,002	473	769
Pasture-Irrigated	2,437	2,070	2,009	1,947	2,019	1,953	1,887	1,820	1,754	1,688	1,621	1,555	1,480
Other field crops	176	332	447	489	401	396	672	1,425	1,013	784	555	1,258	1,169
Flowers & Nursery	112	147	173	205	242	283	336	437	494	510	529	645	644
Total Acreage	36,832	37,020	36,490	36,516	34,589	34,657	34,121	32,924	34,796	30,490	31,114	28,401	26,852

CROP TYPE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fruits and Nuts	6,366	4,726	4,717	4,477	4,409	4,368	3,621	3,665	3,739	3,734	3,732	3,522	3,404
Grapes	1,012	840	1,023	972	922	902	947	930	889	890	920	875	849
Corn	369	388	622	692	588	629	854	1,118	1,170	1,287	1,440	1,702	1,505
Cucumbers/Squash/Melons	1,606	1,716	1,614	1,171	1,184	967	1,052	907	836	860	639	554	481
Garlic	1,397	485	478	409	420	430	662	948	867	1,052	1,148	1,933	1,450
Peppers	1,686	1,323	999	1,266	1,846	1,524	1,875	1,422	1,172	1,277	1,543	1,587	1,942
Tomatoes	5,551	3,779	4,688	4,201	3,632	3,996	4,127	3,788	2,979	2,870	2,851	3,786	2,718
Other veggie/truck	3,373	3,377	3,525	3,351	3,237	2,738	3,170	3,579	2,850	2,501	2,566	2,513	2,773
Hay-Alfalfa	420	291	257	313	1,151	1,575	1,603	1,249	820	531	434	353	109
Other grain & hay	1,988	3,940	4,270	4,736	5,947	6,423	6,043	6,155	4,567	5,197	5,821	5,444	5,097
Sugar Beets	2,315	2,736	229	140	411	409	255	1,029	1,007	571	793	496	224
Pasture-Irrigated	1,404	1,594	1,587	1,570	1,469	1,711	1,585	1,459	1,334	1,208	1,082	1,082	1,082
Other field crops	1,125	1,064	1,041	1,158	1,579	817	989	550	1,335	1,090	1,137	725	1,129
Flowers & Nursery	701	737	838	895	1,030	1,113	1,265	1,335	1,387	1,386	1,535	1,548	1,522
Total Acreage	29,313	26,997	25,889	25,351	27,824	27,604	28,047	28,134	24,951	24,454	25,641	26,121	24,286

acreage for the study area Zone W-5 as a whole rather than break the estimates down further by WSA.

For each of the three years with DWR surveys, the ratio of W-5 acreage (as determined from the DWR survey maps) to total acreage (as reported in the county crop report) was computed for each major crop grouping. These ratios were then linearly interpolated for the years in-between the DWR survey years. The W-5 acreage for each major grouping is then computed by multiplying the acreage from the county crop report by the ratio calculated for that year. Figure 10 summarizes the acreage by major crop grouping. The irrigated acreage are presented graphically in Figure 11.

Figure 11



We investigated using the District's acreage data for Zone W-2 (North County) to aid in estimating the south county acreage. Recorded agricultural water use and acreage for Zone W-2 extend back to 1967, the beginning of the study period. Unfortunately, information on the agricultural acreage in the hills outside both the W-2 and W-5 boundary is not available. If agricultural acreage in the hills is assumed negligible, south county acreage can be estimated by subtracting the W-2 acreage from the county crop report acreage. We compared the south county acreage estimated in this fashion with the south county acreage determined from the DWR land use surveys for 1967, 1977, and 1990, and the results were inconsistent. One possible reason is that the acreage data collected by the District is self-reported rather than measured. Secondly, the assumption that the acreage of crops grown outside the W-2 and W-5 boundaries is negligible is not true, especially for grain crops and vineyards.

Water Use Coefficient Selection

Simply stated, consumptive use methods compute agricultural water use by multiplying the number of acres by some per acre water use coefficient. Depending on the type of per acre water use coefficient used, adjustments for non-average precipitation or evaporation may be needed.

Alternative Per Acre Coefficient Approaches

Evapotranspiration (ET) is defined as the consumptive use of water by crops. ET varies depending on the soil, solar radiation, humidity, temperature, wind, stage of plant development, and the crop itself. The annual evapotranspiration of applied water (ETAW) is less than the total ET of a crop because rainfall provides some of the crop requirements. The rainfall that contributes to the crop water need, known as the effective precipitation, is subtracted from the total crop ET to determine the ETAW (that portion of the crop ET provided by irrigation). Applied water requirements (AW) include the total water applied, reflecting ETAW, leaching requirements and irrigation efficiency.

Tables of average AW and ETAW coefficients for different crops for different geographic areas are available. ET is normally calculated from ETo and Kc, where ETo is defined as the ET of turf grass and Kc is a ratio relating the needs of the crop being analyzed to that of the reference turf grass. ETo varies with climate and soil conditions. ETo data is often available from CIMIS stations or estimated from pan evaporation data, and tables of Kc values for different crops are available.

Selection of Per Acre Coefficients

The intent of the study was to estimate historical use as accurately as possible, including the variability in water use that occurs due to different weather conditions. With this in mind, we investigated using pan evaporation data to estimate ETo and using rainfall records to estimate effective precipitation, so that applied water factors could be calculated from the actual climatic data.

The District has monthly pan evaporation at the Alamitos station throughout the study period, so calculating ETo for each month is straightforward. Computing effective precipitation, however, is more complicated. Effective precipitation is only that rainfall that contributes to the water needs of the crop. Intense rainfall that generates surface runoff or rainfall outside the growing season that does not contribute to soil moisture available to the plant during growing season is not effective precipitation. The computation of effective precipitation is crop specific to the extent that growing season and root zone depths differ. Because the effective precipitation would have to be calculated for each crop separately, we decided that using ET coefficients was not practicable. The approach we chose to use in this study, and the approach used by DWR in its water use computations, is the AW coefficient approach.

Tables of ETAW and AW factors for different crops for different hydrologic regions are available from a number of sources. DWR's Bulletin 113 series, Vegetative Water Use in California, include tables of ETAW and AW for principal crops for different hydrologic regions. The most recent in the series, Bulletin 113-4, was published in 1986. Bulletin 113-3, published in 1975, is still used by DWR as a reference for estimated ETAW water factors. The District's Worksheet B, used for preparing semi-annual water production statements, includes a table of AW factors for estimating agricultural water use for calculating groundwater charges. In 1992, the District retained Greg Jogensen and Kenneth H. Solomon of the Center for Irrigation Technology at the California State University Fresno to analyze the District's Table of Applied Water Factors and recommend revisions. The report "Analysis of Crop Water Requirements and Irrigation Efficiencies for Santa Clara County" was the result of their investigation.

We evaluated the feasibility of developing AW coefficients from the available metered data for south county. For the data to be useful in developing AW coefficients, only one crop can be served by the meter. Even though much of the water use in south county is metered, the number of single-crop meters is too small to develop a reliable list. We compared the AW coefficients computed from these meters to the published lists of coefficients with the intent of verifying our selection of published coefficients, but the metered data was too inconsistent for even this use.

Of the lists of coefficients, the ETAWs in DWR Bulletin 113-3 with an assumed irrigation efficiency of 80% gave AWs that were closest to those indicated by the metered data. The other sources, with the exception of the District's Worksheet B list, all give higher AWs than the metered data.

We relied most heavily on the Bulletin 113-3 coefficients because this Bulletin is the most widely used reference and because such a choice was not counter-indicated by the metered data. Unfortunately, this list is short. For crop groups not on the B113-3 list, we selected crop factors from the next most credible available source, based on the consistency of that source with the B113-3 list. The crop factors used in our analysis and how they were selected are shown in Figure 12. By comparison, lawns typically use 4 af/acre/year.

Figure 12. Crop Factors Used in the Analysis

Crop Type	Crop Factor (af/acre)	Source
Fruit and Nuts	2.5	Table 17, DWR B113-3, with 80% efficiency
Grapes	1.0	Table 17, DWR B113-3, with 80% efficiency
Corn	1.9	Table 17, DWR B113-3, with 80% efficiency
Cucumbers/Squash/Melons	2.2	Table H-1, DWR B133-4
Garlic	1.9	Table H-1, DWR B133-4 (dry onions)
Peppers	2.2	Table H-1, DWR B133-4
Tomatoes	1.9	Table 17, DWR B113-3, with 80% efficiency
Other Vegetables/Truck	2.3	Table H-1, DWR B133-4
Hay Alfalfa	2.8	Table 17, DWR B113-3, with 80% efficiency
Other Grain & Hay	0.3	1990 DWR Land Use Survey Packet
Sugar Beets	2.5	Table 17, DWR B113-3, with 80% efficiency
Pasture - Irrigated	3.3	Table 17, DWR B113-3, with 80% efficiency
Other Field Crops	2.5	1990 DWR Land Use Survey Packet
Flowers & Nursery	2.5	1990 DWR Land Use Survey Packet

Irrigated Crop Water Use Estimate

Base Estimate

The irrigated crop water use estimated using the acreage totals and the applied water coefficients described above are shown in Figure 13. This water use represents the expected water use given average weather conditions.

Figure 13. Estimated South County Irrigation Water Use by Year, in Acre-feet

CROP TYPE	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Fruits and Nuts	52,540	51,626	49,141	46,048	39,972	36,595	32,811	29,359	26,683	20,425	19,839	17,815	16,978
Grapes	1,857	1,658	1,541	1,592	1,512	1,613	1,433	1,410	1,376	1,270	1,288	1,220	1,184
Corn	1,197	723	1,404	801	940	699	479	329	477	516	287	238	364
Cucumbers/Squash/Melons	2,545	2,301	2,935	2,873	2,921	3,219	2,927	2,563	3,273	4,254	3,771	3,355	2,410
Garlic	967	1,833	1,760	2,247	2,365	2,040	2,029	1,366	1,643	2,157	1,575	1,997	1,812
Peppers	2,816	3,213	2,905	2,371	2,778	3,124	2,918	3,038	2,394	2,444	3,358	3,153	3,787
Tomatoes	9,249	10,258	8,031	10,264	9,462	10,633	11,929	14,376	16,151	14,294	15,786	12,132	11,253
Other veggie/truck	5,032	4,447	6,072	5,467	4,382	4,743	5,429	5,179	6,022	6,986	6,196	6,937	7,331
Hay-Alfalfa	1,002	765	1,138	1,042	1,057	1,321	2,801	906	908	1,133	1,491	1,232	1,161
Other grain & hay	0	115	243	308	491	597	716	636	811	298	728	645	398
Sugar Beets	610	807	651	1,749	2,989	3,325	1,664	975	4,121	4,145	2,505	1,183	1,923
Pasture-Irrigated	8,042	6,833	6,628	6,424	6,664	6,445	6,226	6,007	5,788	5,569	5,350	5,132	4,882
Other field crops	440	830	1,117	1,222	1,003	990	1,680	3,562	2,534	1,959	1,388	3,145	2,921
Flowers & Nursery	280	367	432	512	605	706	839	1,092	1,234	1,275	1,323	1,613	1,610
Total Water Use	86,579	85,776	83,998	82,920	77,142	76,049	73,880	70,798	73,416	66,726	64,886	59,794	58,016
Adjust for Weather +/- 10%	x .90	n.c.	n.c.	x 1.10	n.c.	n.c.	n.c.	x .90	n.c.	n.c.	n.c.	x .90	n.c.
Adjusted Totals	77,921	85,776	83,998	91,213	77,142	76,049	73,880	63,718	73,416	66,726	64,886	53,814	58,016

CROP TYPE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fruits and Nuts	15,914	11,815	11,791	11,194	11,021	10,921	9,053	9,162	9,346	9,334	9,330	8,806	8,510
Grapes	1,012	840	1,023	972	922	902	947	930	889	890	920	875	849
Corn	702	737	1,182	1,315	1,117	1,195	1,623	2,124	2,222	2,445	2,736	3,233	2,860
Cucumbers/Squash/Melons	3,534	3,775	3,551	2,576	2,604	2,128	2,315	1,995	1,840	1,892	1,406	1,218	1,059
Garlic	2,654	922	909	778	798	818	1,257	1,802	1,647	1,999	2,181	3,674	2,755
Peppers	3,710	2,911	2,199	2,786	4,062	3,353	4,124	3,128	2,579	2,809	3,395	3,491	4,272
Tomatoes	10,547	7,181	8,908	7,982	6,900	7,591	7,842	7,196	5,659	5,453	5,417	7,193	5,165
Other veggie/truck	7,757	7,766	8,108	7,708	7,445	6,299	7,290	8,232	6,555	5,753	5,902	5,781	6,379
Hay-Alfalfa	1,177	815	720	877	3,224	4,409	4,488	3,498	2,296	1,488	1,215	987	304
Other grain & hay	596	1,182	1,281	1,421	1,784	1,927	1,813	1,847	1,370	1,559	1,746	1,633	1,529
Sugar Beets	5,787	6,841	573	350	1,027	1,024	639	2,573	2,518	1,428	1,983	1,241	559
Pasture-Irrigated	4,633	5,261	5,238	5,181	4,849	5,646	5,231	4,816	4,401	3,986	3,571	3,571	3,571
Other field crops	2,813	2,659	2,602	2,894	3,947	2,044	2,471	1,375	3,337	2,724	2,843	1,813	2,823
Flowers & Nursery	1,753	1,844	2,096	2,237	2,575	2,783	3,161	3,337	3,468	3,465	3,838	3,869	3,806
Total Water Use	62,589	54,549	50,180	48,270	52,274	51,040	52,253	52,014	48,128	45,225	46,481	47,386	44,440
Adjust for Weather +/- 10%	n.c.	n.c.	x .90	x .90	x 1.10	n.c.	x .90	n.c.	x 1.10	n.c.	n.c.	n.c.	n.c.
Adjusted Totals	62,589	54,549	45,162	43,443	57,502	51,040	47,028	52,014	52,941	45,225	46,481	47,386	44,440

Adjustments for Weather

Different methods for adjusting the base estimated water use for different irrigation needs in years with non-average weather were investigated. Unfortunately, regression analysis was infeasible due to insufficient data. Instead, we chose to select threshold precipitation values, beyond which adjustment factors could be reasonably established and applied.

The Peabody Ranch precipitation gaging station was used for this study since it had the most complete record in the study area for the study period. This station, with a mean annual precipitation of 19 inches, compares reasonably to other south county valley floor gages with precipitation means ranging from 17 to 21 inches.

Growing seasons differ by crop; however, March through September was selected as the typical growing season for south county based on the crops being irrigated there. Effective precipitation, not annual precipitation, is what impacts applied water application. DWR assumes that all rainfall occurring during the growing season is effective, neglecting the possibility of intense storms that generate surface runoff or rainfall so early in the season that evaporation from the soil is possible. During the non-growing season, only rainfall exceeding the potential ET for each month contributes to soil moisture conditions.

Downward Adjustments of Estimated Applied Water Use

Years with both higher than average precipitation during the growing season and good pre-season soil moisture conditions were considered candidates for downward adjustment of the irrigation water use estimate.

For the Peabody gage, the growing season rainfall averaged 5.6 inches. For the study period, nine years had growing season rainfall exceeding the mean, ranging from 11.8 to 6.8 inches: 1983, 1991, 1967, 1978, 1982, 1974, 1986, 1975, and 1976. Fourteen years had pre-growing season rainfall in excess of the potential ET, potentially contributing to good pre-growing season soil moisture conditions: 1969, 1983, 1973, 1980, 1982, 1986, 1978, 1967, 1979, 1970, 1974, 1971, 1984, and 1985. Based on these two considerations, the years 1967, 1974, 1978, 1982, 1983, and 1986 were selected for downward adjustment .

To determine the magnitude of downward adjustment, the average effective rainfall for the years selected for downward adjustment was compared to the average weighted crop factor over the study period. The effective rainfall for these years ranged from 15% to 30% of the expected applied water use. It was assumed that half the effective rainfall would offset pumped irrigation, and adjusted the estimated irrigation water use down by 10%.

Upward Adjustments of Estimated Applied Water Use

The average growing season rainfall of 5.6 inches contributes only a fraction of the water requirements of crops. Four years had less than half that amount - 1972 with 0.7 inches, 1970 with 1.8 inches, 1984 with 2.0 inches, and 1988 with 2.7 inches. Although 1972 had low growing season rainfall, 1972 also had the lowest evaporation of any year in the 1967 through 1992 period, so no weather adjustment was made. The estimated irrigation water use was adjusted upward by 10% for each of the years 1970, 1984, and 1988.

Figure 14 shows the rainfall and weather adjustment for each year. Figure 13 tabulates the water use for each year in the study period. Figure 15 shows the water use graphically.

Figure 15

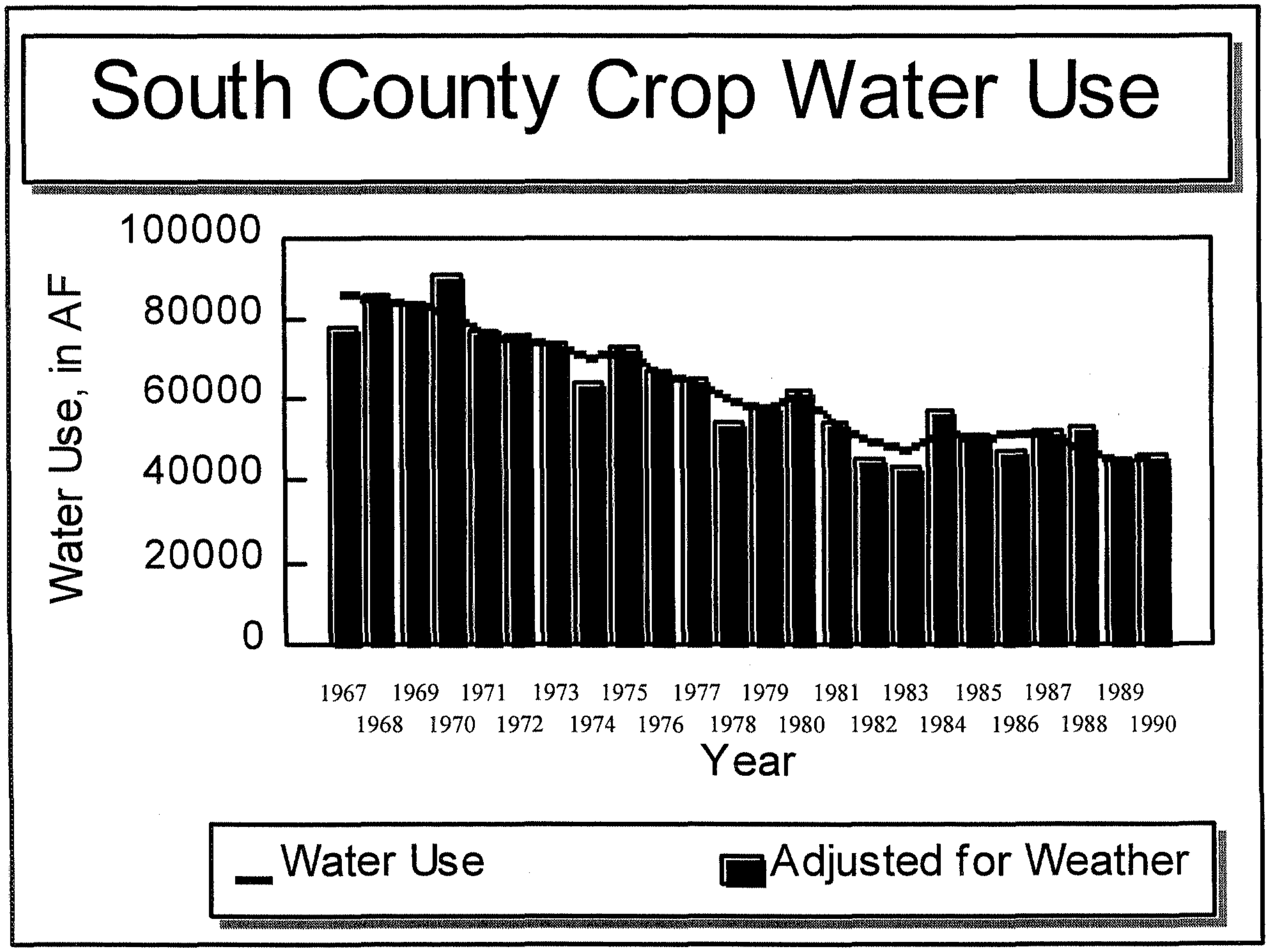


Figure 14. South County Rainfall (Peabody Ranch)

Year	Annual Rainfall, in inches	Growing Season Rainfall, in inches	Water Use Adjustment
1967	18.9	10.8	down 10%
1968	N/A	N/A	
1969	31.1	3.3	
1970	22.7	1.8	up 10%
1971	9.8	2.9	
1972	12.4	0.7	
1973	26.5	3.5	
1974	19.3	9.8	down 10%
1975	15.4	7.8	
1976	12.4	6.8	
1977	13.2	3.8	
1978	27.7	10.8	down 10%
1979	23.1	3.8	
1980	20.5	5.1	
1981	22.7	3.9	
1982	32.4	10.5	down 10%
1983	35.3	11.8	down 10%
1984	11.9	2	up 10%
1985	15.3	4.8	
1986	22.2	8.6	down 10%
1987	15.1	3.5	
1988	11.5	2.7	up 10%
1989	9	4.4	
1990	11.7	4.6	
Avg.	19.1	5.6	

Livestock Water Use

Agricultural activity in the county includes the raising of livestock, such as cattle, dairy cows, sheep, hogs, and chickens. Livestock and poultry water use was estimated using the annual inventories in the County Crop Reports and applying the District's Worksheet B water use per head factors.

Based on a conversation with Joe Ferrari of the County Department of Agriculture, about 80 to 85% of the livestock in the county are in the southern portion of the county, with about 80% of those being up in the hills outside of the District's water zone. This means less than a quarter of the livestock in the county are within the study area. Figure 16 below summarizes the number of head and the livestock water use for the county as a whole for the study period. Given the uncertainty over the exact number of head in south county and the insignificant water use, the use of water by livestock was not included in the south county water use estimate totals.

Figure 16. Santa Clara County Livestock and Livestock Water Use

Year	Cattle & Milk Cows	Sheep & Hogs	Chickens	Countywide Water Use (AF)
1967	39,600	2,800	879,000	383.0
1968	39,850	2,150	989,000	382.6
1969	43,900	2,450	828,000	415.0
1970	39,860	2,060	862,000	378.4
1971	38,040	1,100	849,000	354.5
1972	38,750	800	917,000	359.8
1973	30,300	500	758,000	281.4
1974	42,000	800	767,300	383.3
1975	34,700	1,330	728,000	324.9
1976	33,600	1,050	800,000	315.2
1977	26,840	2,335	800,000	268.8
1978	22,509	1,358	710,000	221.4
1979	23,260	900	617,000	221.4
1980	25,130	1,900	697,000	247.8
1981	22,880	1,650	622,000	224.6
1982	36,000	1,700	600,000	335.6
1983	58,200	1,300	795,000	525.5
1984	57,100	2,400	670,000	522.1
1985	71,500	3,300	680,000	652.0
1986	54,500	2,500	700,000	501.8
1987	53,800	2,600	500,000	491.3
1988	67,000	1,650	480,000	594.5
1989	67,600	4,250	485,000	621.7
1990	72,000	4,300	350,000	655.8
1991	71,000	4,500	300,000	647.6
1992	63,800	4,300	350,000	586.3

1.) Cattle & sheep water use AF = (no. of head) x 2,760 gal/head x 1/(325,850 gal/AF)
2.) Chicken water use AF = (no. of head) x 1 unit/100 head x 883.2 gal/unit x 1/(325,850 gal/AF)

Chapter 3. Non-Agricultural Water Use

Although agricultural water use remains the majority of the water use in south Santa Clara County, non-agricultural water use is a significant and growing demand in the area. Because of the data available, we chose to break non-agricultural water use into two components: city-supplied water and independently pumped water. The two municipalities providing water in the South Santa Clara County area are the cities of Gilroy and Morgan Hill, together serving more than 70% of the south county population.

For the non-agricultural, or municipal and industrial, water use estimation, the south county region was broken down into four water service areas (WSAs): COYOTE, MORGNL, GILROY, and SMARTN. These WSAs are loosely equivalent to the U. S. census tract boundaries in the area.

City-Supplied Water Use

Every ten years, the California Department of Water Resources (DWR) produces Bulletin 166, "Urban Water Use in California". These documents include tables showing the annual water supplied by city by year and the average population served for each of the ten prior years. These documents were used as the source of information on city-supplied water during the study period.
Unfortunately, Morgan Hill was not included in DWR Bulletin 166-2, the bulletin covering years 1960 through 1969. Therefore, for the years 1967 through 1969, the source of water use for the city of Morgan Hill was a table received from the city showing its water use for the years 1956 through 1990. This table compared well with the DWR Bulletin 166-3 and 166-4 data most of the time, with discrepancies of up to ten percent in a few years. We chose to use the published source data when available, relying on the table from the city only when data was not available in the DWR bulletins.

The city-supplied water use for the study period ranged from a low of 3,300 acre-feet in year 1967 to a high of 13,170 in year 1988, as is shown in Figures 17 and 18.

Figure 17

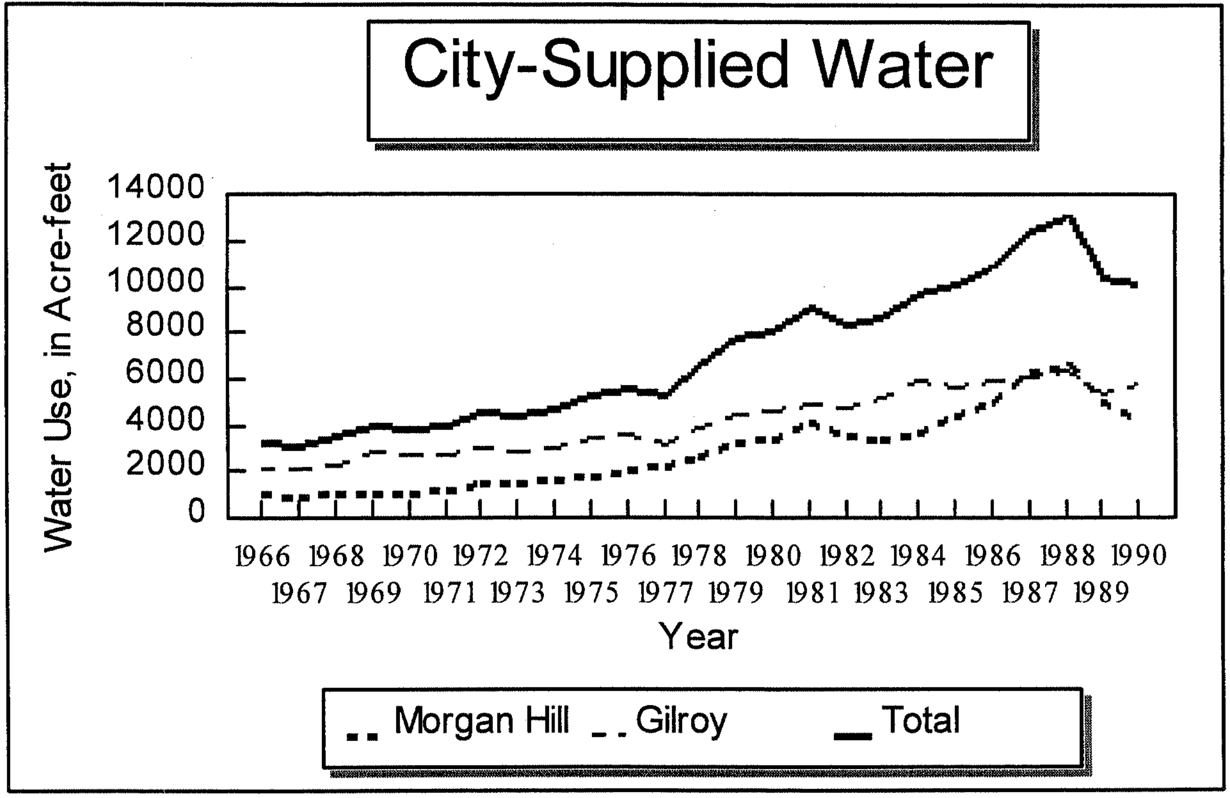

City-Supplied Water
Water Use, in Acre-feet
14000
12000
10000
8000
6000
4000
2000
0
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
Year
Morgan Hill
Gilroy
Total

Figure 18. City-Supplied Water, in Acre-feet

Year	Gilroy City-Supplied Water Acre-Feet	Morgan Hill City-Supplied Water Acre-Feet	Total City-Supplied Water Acre-Feet
1967	2,194	1,102	3,295
1968	2,397	1,046	3,442
1969	2,951	1,217	4,168
1970	2,790	1,195	3,985
1971	2,706	1,361	4,067
1972	3,074	1,533	4,607
1973	2,958	1,632	4,590
1974	3,123	1,717	4,840
1975	3,441	1,897	5,338
1976	3,600	2,156	5,756
1977	3,209	2,261	5,470
1978	3,960	2,814	6,774
1979	4,531	3,349	7,880
1980	4,682	3,501	8,183
1981	4,897	4,289	9,187
1982	4812	3,624	8,436
1983	5,234	3,541	8,774
1984	5,992	3,846	9,838
1985	5,658	4,499	10,157
1986	5,966	5,069	11,035
1987	6,145	6,446	12,591
1988	6,465	6,705	13,170
1989	5,468	5,126	10,594
1990	5,825	4,433	10,258

Independent Pumping

A significant percentage of the non-agricultural water use in south county is provided by hundreds of individually owned wells. For years prior to 1987, when the District began requiring well owners in this area to register and estimate their water use, information on the water pumped by these wells is not available.

Given the data obtainable, the best way to estimate the water use for south county prior to the onset of District records is to use a per-capita method. A per capita method because we had data sources that would enable us to estimate the non-system served population, but no data that would allow us to estimate the number of households or the number of employees within and outside of the city service area (just for the census tract as a whole).

The accuracy of per-capita methods can be adversely impacted if large amounts of water use are used by industry or other users whose water use is not necessarily proportional to population. Several such users exist in south county. We accounted for these major independent pumpers separately. We then estimated the remaining non-agricultural water use using a per capita method and estimates of the population **not** served by the municipalities.

Although this approach is somewhat crude, even a large error in the estimation of independent non-agricultural water use would produce a small error in the total use estimate since non-agricultural independent pumping is small compared to the total water use in south Santa Clara County. Independent non-agricultural pumping ranges from a low of 5,500 acre-feet in 1967 to a high of 7,800 acre-feet in 1988.

Major Pumpers

To address the complication of major independent pumpers, we first looked at the historical data collected by the District since 1987. We determined the owners of every well that pumped more than 100 acre-feet in any six-month period. The list of large pumpers determined in this fashion agreed well with the list maintained by Water Revenue Division, with the exception of several mutual water companies that Water Revenue also identifies as large users. We did not handle mutual water companies separately since their water use patterns are proportional to population served; their water use is captured in the per capita analysis.

We estimated the water use of the major independent pumpers we identified individually. These estimates were based on their water use since 1987, when the business was established, and what information we were able to find on how their business changed during the 1967 through 1987 study period. In cases where we did not have sufficient information to estimate how the water use may have changed over the study period, constant water use was assumed. During the study period, the estimated major pumping ranged from 3,200 to 3,900 acre-feet annually.

Per Capita Estimates for Other Pumpers

Estimating the water use of the remaining independent pumpers was a multi-step process.

First, the appropriate population was calculated. Although population data was readily available by census tract, we discovered that the geographic boundaries of the census tracts changed over time. Some effort was expended to reconcile the census tract boundaries with the District's Water Zone W-5 and WSA boundaries, yielding the total population of the south county area by

WSA. The population served by the municipal systems was then subtracted from the census population to give population served by independent wells. The total population by WSA, the system-served population, and the population served by independent wells (non-system population) are all shown in Figure 19. In other years, the population served by independent wells was interpolated from these values.

Figure 19. Population: City Water System Served and Independent Well Served

Year	WSA Population	City-Supplied Population	Non-City Population
1966	25,925	14,800	11,125
1970	30,507	19,400	11,107
1980	56,619	39,269	17,350
1990	75,258	55,845	19,413

Next, the choice of per capita water use coefficients was investigated. We looked at the historical per capita water use for each of the four WSAs as computed from District recorded water use since 1988. This approach was not fruitful: the number of years of recorded data were few and all drought-impacted, and no clear useful patterns were discernable. We then looked at the per capita water use for the cities of Morgan Hill and Gilroy, as reported in DWR Bulletin 166. The patterns were more consistent than those from District recorded water use, but still showed some trends not easily explained. For example, the per capita water use for Morgan Hill increased by 20% in 1981 but dropped back to 1980 levels in 1982. This idiosyncrasy was due to a one-year drop in the reported population served in 1981. Given the minor inconsistencies in the data, we chose to use the average per capita water use for the cities from 1970 through 1990, which was 0.210 acre-feet per capita annually. The water use by WSA for independent pumpers is shown in Figure 20.

Figure 20. Water Use Supplied by Independent Pumpers

Year	Gilroy		Morgan Hill		Coyote		San Martin		Total Independent Pumpers Acre-feet
	Major Users Acre-feet	Other Users Acre-feet	Major Users Acre-feet	Other Users Acre-feet	Major Users Acre-feet	Other Users Acre-feet	Major Users Acre-feet	Other Users Acre-feet	
1967	2,500	716	0	443	380	284	275	892	5,490
1968	2,533	703	0	459	380	283	275	889	5,522
1969	2,566	690	0	474	380	282	275	887	5,554
1970	2,599	677	0	490	380	282	275	884	5,586
1971	2,631	696	0	463	380	315	275	990	5,750
1972	2,664	715	0	437	380	347	275	1,096	5,914
1973	2,697	734	0	410	380	380	275	1,202	6,078
1974	2,730	753	0	384	380	413	275	1,307	6,242
1975	2,730	772	0	357	380	446	275	1,413	6,373
1976	2,730	791	0	331	380	479	275	1,519	6,504
1977	2,730	810	0	304	380	511	275	1,625	6,635
1978	2,730	828	0	278	380	544	275	1,731	6,766
1979	2,730	847	0	251	380	577	275	1,837	6,897
1980	2,730	866	0	225	380	610	275	1,943	7,029
1981	2,730	884	0	232	390	611	275	1,960	7,082
1982	2,730	903	0	238	399	612	275	1,978	7,134
1983	2,730	921	0	245	337	612	275	1,996	7,115
1984	2,730	939	0	251	392	613	275	2,013	7,213
1985	2,730	957	0	258	394	614	275	2,031	7,259
1986	2,730	975	0	264	365	615	275	2,049	7,273
1987	2,730	993	0	271	375	616	275	2,067	7,327
1988	3,289	1,011	0	278	335	617	229	2,084	7,844
1989	2,661	1,029	0	284	404	618	298	2,102	7,397
1990	2,853	1,047	0	291	422	619	286	2,120	7,637

Chapter 4. Water Use And Water Supply

Figures 21 and 22 summarize the historical water use for South Santa Clara County, as presented in Chapters 2 and 3.

Figure 21. South Santa Clara County Water Use - Agricultural and Non-agricultural

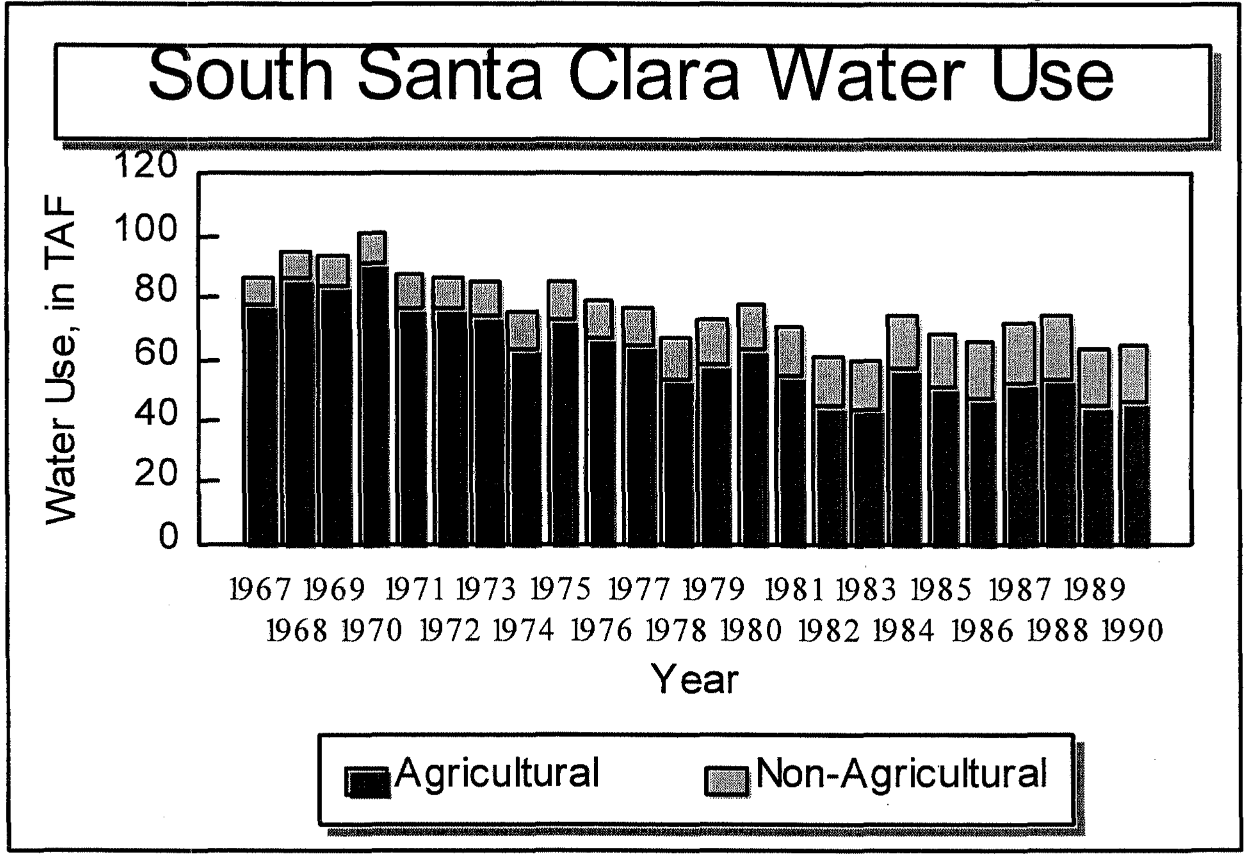


Figure 22 also shows the quantity of the total use met by surface deliveries. The surface water deliveries in the table reflect deliveries from District facilities, such as the Santa Clara Conduit. Although some demand is served by independent water rights that allow users to divert from the creeks, this water supply is not reflected in the table. According to the State Water Resources Control Board Division of Water Rights, water rights totaling about 1,000 acre-feet are held by other diverters in the study area. Historical use data for these rights are available from the SWRCB; however, this information must be hand-retrieved from their files manually. Given the small water use, the water served by independent water right was neglected. Lastly, the use served by groundwater, calculated by subtracting the surface water use from the total water use, is shown in the last column.

Figure 22. South Santa Clara County Estimated Historical Water Use

Year	(a) Total Est. Non-agr Water Use Acre-feet	(b) Crop Water Use, w/ weather adj. Acre-feet	(c=a+b) Total Water Use Acre-feet	(d) Use Met by Surface Deliveries, Acre-feet	(e=c-d) Water Use Met by Groundwater, Acre-feet
1967	8,786	77,921	86,706		86,706
1968	8,965	85,776	94,741		94,741
1969	9,722	83,998	93,720		93,720
1970	9,571	91,213	100,784		100,784
1971	9,817	77,142	86,959		86,959
1972	10,521	76,049	86,569		86,569
1973	10,668	73,880	84,548		84,548
1974	11,082	63,718	74,800		74,800
1975	11,711	73,416	85,127		85,127
1976	12,260	66,726	78,985		78,985
1977	12,105	64,886	76,991		76,991
1978	13,541	53,814	67,355		67,355
1979	14,777	58,016	72,793		72,793
1980	15,212	62,589	77,801	532	77,269
1981	16,269	54,549	70,817	1,250	69,567
1982	15,570	45,162	60,732	629	60,103
1983	15,890	43,443	59,333	272	59,061
1984	17,051	57,502	74,553	362	74,191
1985	17,416	51,040	68,456	454	68,002
1986	18,308	47,028	65,336	421	64,915
1987	19,919	52,014	71,932	461	71,471
1988	21,014	52,941	73,954	825	73,129
1989	17,991	45,225	63,216	559	62,657
1990	17,896	46,481	64,377	1,338	63,039

Natural Groundwater Yield Computation

Natural groundwater yield can be computed using water use and groundwater storage data using a water balance approach:

$$\Delta Storage = WaterSupply - WaterUse$$

By subtracting the demand met through surface supplies from the total water use, the equation can be used for groundwater only, and calculating the surface water supplies and change in surface water storage is unnecessary. Thus the equation becomes

$$\Delta GroundwaterStorage = FacilitiesRecharge + NaturalGroundwaterYield - GroundwaterUse$$

Change in groundwater storage and historical facilities recharge are available from District records and the historical groundwater use was calculated in Figure 22, so this equation can be used to solve for historical natural groundwater yield. The change in groundwater storage, facilities recharge, and estimated natural groundwater yield are shown in Figure 23.

Figure 23. Estimated Natural Groundwater Yield

Year	Groundwater Pumping Acre-feet	Artificial Recharge Acre-feet	Change in Storage Acre-feet	Natural Groundwater Yield Acre-feet
1967	86706			
1968	94741	20835	-48000	25906
1969	93720	24906	50000	118814
1970	100784	29456	-13900	57428
1971	86959	27654	-15000	44305
1972	86569	23564	-52000	11005
1973	84548	29621	47000	101927
1974	74800	33132	8000	49668
1975	85127	35674	9000	58453
1976	78985	24229	-78700	-23944
1977	76991	14035	-23300	39656
1978	67355	28582	41000	79773
1979	72793	30744	4000	46049
1980	77269	29481	22000	69788
1981	69567	29743	-34000	5824
1982	60103	32287	59000	86816
1983	59061	37679	13000	34382
1984	74191	31321	-25000	17870
1985	68002	26985	-13000	28017
1986	64915	27560	21000	58355
1987	71471	24615	-27000	19856
1988	73129	21124	-41000	11005
1989	62657	23614	-16000	23043
1990	63039	25047	-24000	13992

Conclusions

Non-agricultural water use, although growing as a percentage of total use due to increasing population and decreasing agriculture, remains the lesser portion of water use in south Santa Clara County. The majority of the growth in non-agricultural water use is growth in the water provided by municipal systems (the cities of Morgan Hill and Gilroy), although water supplied by independent pumping has also increased over the study period. Agricultural water use is declining for two reasons: most significantly, the conversion of agricultural land for development but also the shift in cropping patterns to less water-intensive uses.

Most of the non-agricultural water use in the region is supplied by the municipal systems of Gilroy and Morgan Hill and has been recorded with accuracy. Although the methods used for estimating non-agricultural water use provided by independent pumping is very crude, even a large error in this estimation would produce a small error in the total use estimate since the non-agricultural independent pumping is only about ten percent of the total water use.

Because agricultural water use is such a large component of water use in south Santa Clara County, uncertainties in that estimation can have significant impact on the total water use estimation and thus on the natural groundwater yield calculation.

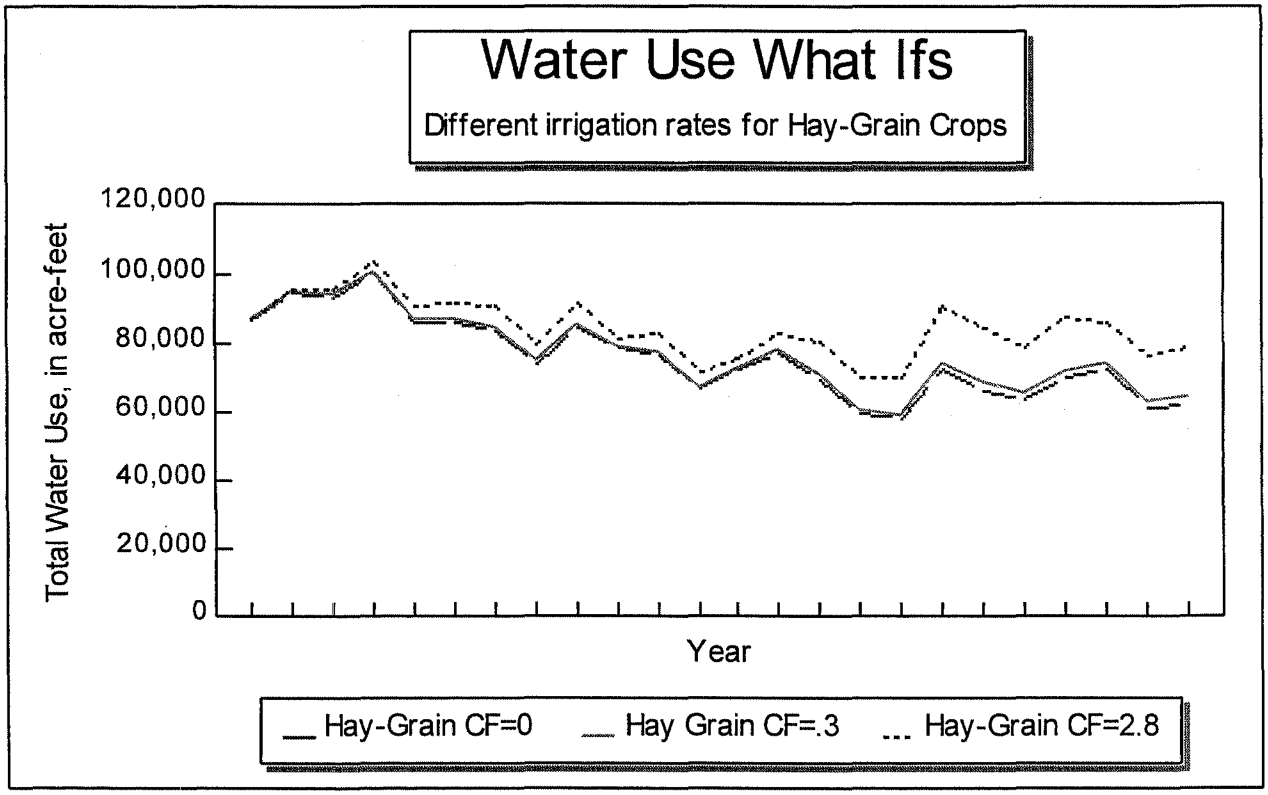
One uncertainty in the analysis is the choice of crop water use coefficients. To be able to capture the variations in water use due to weather would have been preferable, but to do so with greater accuracy than the weather adjustments used in the analysis would have required using ETo data (which can be estimated from available historical pan evaporation data) and estimates of effective precipitation and irrigation efficiencies. This alternate method has uncertainties in the computation of effective precipitation, however. For example, the intensity of the storm effects the amount of the rainfall that can be considered effective precipitation; a heavy rain that produces surface runoff may contribute less to the crop than a more gentle rain might. In addition, this calculation is crop specific, since each crop has a different growing season and a different root zone. For these reasons, the simpler method of weather adjustments was used in the analysis.

Given the decision to use applied water coefficients rather than evapotranspiration data, the next significant uncertainty is the choice of applied water coefficients used. We selected the coefficients from a widely used reference whose values appeared consistent with the little metered data available. If more data were to become available on actual crop usage in this region, the selection of coefficients could be revisited.

As for the irrigated acreage estimates, the DWR land use surveys are quite accurate. Although the method for estimating the acreage in non-survey years using the county crop reports is not ideal, this approach is probably as accurate as possible given the historical data available.

The most sensitive uncertainties in the agricultural water use estimation are the assumptions made matching crop types and water use coefficients from the DWR sources with the crop types listed in the county crop report. For example, the county crop report listed both "pasture-improved" and "pasture-irrigated". Based on conversations with Kevin O'Day at the County Department of Agriculture and Rich Cocke at DWR, our analysis treated "pasture irrigated" as equivalent to DWR's irrigated pasture, with a crop factor of 3.3 acre-feet per acre, and "pasture-improved" as unirrigated pasture. We equated DWR's "P1 alfalfa pasture", with an applied water coefficient of 2.8, with the county crop report's "hay-alfalfa" designation and combined the county crop report's hay-grain, barley, wheat, and oats categories into "other grains and hay" and used an applied water coefficient of 0.3 based on a conversation with Rich Cocke at DWR. Given the high crop factor for irrigated pasture and the large acreage of improved pasture, the water use if this acreage was actually irrigated would be large. The grains and hay acreage is also large; if this acreage was actually irrigated more heavily, like alfalfa hay, or completely unirrigated, there would be a significant impact to the estimated south county water use. Figure 24 illustrates the change in the estimated water use for different assumptions regarding irrigation rates for hay-grains. If hay-grain were irrigated at 2.8 acre-feet per acre, rather than the 0.3 acre-feet per acre estimated in the report, the total water use for south Santa Clara County in some years could have been 15,000 acre-feet higher.

Figure 24. Illustration of the Impact on Water Use of Different Irrigation Assumptions



Neglecting the water use met through independent water rights in the water supply computations is an approximation, but the water supplied through these sources in the study area is small. Larger uncertainties in the natural groundwater yield computation are the historical facilities recharge and the historical change in groundwater storage, both of which were taken from the District's BFDATA computer program. Unfortunately, these data were reported in water year while the analysis in this report are based on calendar year, further complicating the groundwater yield computation.

Appendix A. Matrix of Information Sources

South County Historical Water Use:
Matrix of Information Sources

Data Source	Data Type	Years Included	Data Derivation	Type of Data Breakdown	Geographic Breakdown	Use
SCVWD Records of Cities of Gilroy and Morgan Hill Water Use	Water Production and Sewage Treatment Plant Inflows; and "City of Morgan Hill Water Production Record"	Water Years 1975-76 to Present; From 1956 to 1990 for "City of Morgan..."	Metered Municipal System Deliveries; Earlier years for Morgan Hill are on one page summary for 1956 through 1990	Acre-feet monthly; except for Morgan Hill's one page summary, which states only the year (presumably calendar) and production in gallons and acre-feet	Areas served by respective cities	Provides actual measured data; subtract water prod. from sewage inflow for outdoor use
SCVWD - Central Files; former Gavilan WCD records in archive storage	Groundwater collection reports prepared as agenda items/board mtgs	July 1986 thru Nov 1987	Unknown; Gavilan Financial, Temporary Box # 9004:	$$ collected for M&I, Ag, Past Due, Penalty, Credit, all by month	Gavilan District	Can divide $$ by rates to get Ac-ft, use for reference
	Water Sales Revenues	Fiscal Years ending June 1980, 81, 82, 83, 84, 85, 87	Financial Audits; Annual Statements of Income & Expenses	Total water sales in $$ for 1980,81,83,84,85, and 87; res, bus, indus, irrig, and other for 82	Gavilan District	For 1982, can div. $$ by rates to get Ac-ft, for ref.
SCVWD - Central Files	"Groundwater Studies" Engr. Analyses for "Annual Survey Report on Groundwater Conditions"	1962-63 thru 1971-72	Engineering analyses from County Planning Dept and Census data, Bulletin No. 7 unit consumptive use values adjusted for precipitation conditions	Consumptive use, GW extractions, subsurface inflow and outflow, in Coyote and Llagas Subbasins;	Coyote and Llagas Subbasins	Usefulness depends on year and analysis (further review req'd)
SCVWD - Program Analysis Division	same as above	1972-73 thru 1984-85	Apparently diminishing level of analysis effort			Same as Above

Data Source	**Data Type**	**Years Included**	**Data Derivation**	**Type of Data Breakdown**	**Geographic Breakdown**	**Use**
SCVWD - Program Analysis Division	South County "Base Year Acreage" compiled for "Water Needs Study" from acreages for specific crops	1990	Land Cover Maps developed by DWR by aerial color slides in June 1990, verified by field inspection and aerial color photos in October 1990	Acreage for _____ specific crops in entire Zone W-5, and total acreage of irrigated land in each Water Service Area (WSA)	Base Year Acreage in total acres for Each WSA in Zone W-5: Coyote, Morgan Hill, San Martin, Gilroy	(Action: this info needs to be assembled or sorted from previous files)
SCVWD - Program Analysis Division	Calculated weighted avg Per Acre Coeff. (crop factor), compiled for "Water Needs Study"	1990	Per Acre Coeffs By comparison w/ other crop factors: DWR Bulletin 113, Jorgensen & Solomon report from CIT Fresno, and District's Water Revenue Worksheet B	Actual crop factors assigned/used for each respective crop; (in files previously developed during preparation of the Division's "Water Needs Study")	Crop factors developed for So Cnty crops in each WSA	Extract respective crop factors, incorporate hydrologic conditions as deemed appropriate
SCVWD - Water Revenue	Groundwater Production	1987 to present	GW Production statements from well owners; most prod. statements use crop factor method for calculating water use	Ag, Ag by crop type, M&I	State well no. &/or summarized by WSA	May require recalc. w/ diff. crop factors incorporating hydrologic conditions
SCVWD - Water Revenue	Surface Water Diversions	1987 to present	As reported on hard cards; meter readings from Operations Techs	Semi-annual and/or monthly; Ag and minor M&I usage	District surface water diversion facility; e.g. pipeline turnouts to irrigators	Quantities may not be significant; need to determine qtys and signif.
SCVWD - Water Measurement	Water meter/hour meter comparison study	Oct 91 thru Sept 92	Water meter, hour meter, and some power meter readings	Monthly meter readings for comparison by meter type	3 M&I wells, and 5 Ag wells	Determine qty water used, significance, usefulness

Data Source	Data Type	Years Included	Data Derivation	Type of Data Breakdown	Geographic Breakdown	Use
SCVWD - Hydrologic Systems	All District hydrologic data	to present	Direct measurement	Precip & evap by inches; daily	Station location, watershed	Use precip data in hydrology-dependent evaluations
SCVWD - Operations	Raw Water Distribution	1989 to present	Joe A.'s distribution spreadsheet	Monthly or semi-annually, depending on quantity	Ac-ft to various facilities (turnouts)	May provide specific locations of surf water use
County - Dept of Agriculture	County Crop Reports (in SCVWD library)	All (1967 - 1987)	County Dept. of Agriculture Records	Harvested Acreage, Tons per Acre; by specific crop, & subtotals by crop type subgroups	Total County Only for veg, nursery prod., livestck/poultry; No & So Cnty for major fruit/nut crops until 1982, then no breakdown	Try to segregate So County qtys as needed; otherwise may provide reasonblness check on other acreage data sources
County - Planning Dept., "INFO" publications (in SCVWD library)	Countywide Land Use Summary: acreages for 99 land use codes in Resid; Indus. Nonmfg; Mfg; Transp, commun, utils; Commercial; Vacant urban; Public & quasi-public open spaces; Agr, extractive, & open land	1967 data published in 1971 "INFO" issues; other years available in more recent issues of "INFO"	Based on countywide land use inventory conducted by County Planning Dept from May to Aug 1967	Nine Categories in "Planning Area" breakdown; add'l subcategories in "Cities" breakdowns	County, Cities in County, Planning Areas in County; all by acres	Break out So County Ag; use other data in "Info" pubs to help refine or break down categories for estimating urban usage

Data Source	Data Type	Years Included	Data Derivation	Type of Data Breakdown	Geographic Breakdown	Use
State - DWR	Irrigated acreage from Land Use Surveys; Methods for determining consumptive use	Surveys of county in 1967, 1977, 1987-90	Aerial photography and field checking	About 80 Ag classes, 15 native classes, various urban classes for resid., comm., industr.	By acre, parcel; resolution of 1:24000 scale USGS 7½ minute maps	Apply crop use coeffs to acreages from parcels & crops in land use survey data to determine Ag water use
State - DWR Bulletin 113-4 April 1986 "Crop Water Use in California"	Acres irrigated for 22 different crops and average total annual ac-ft per acre measured water delivered by crop type	Generally sampled during 10-year period preceding 1986	By direct measurement: "Some of the measurements were made directly by Dept. staff with the assistance of cooperating growers. . . . most of the data were obtained from others who had installed measurement devices. . . . the Dept canvassed farm advisors, agricultural consultants, representatives of irrigation equipment industry, U.S. Soil Conservation Service technicians, and employees of irrigation and water districts to identify growers who measure and maintain records of field irrigation deliveries." (see "Appendix H. Crop Applied Water Data" for add'l discussion)		"No. of Fields," = no. of samples, where one sample is considered to be one field for one year;"Acres Irrigated," and ac-ft per acre delivered (avg total by crop type)	Detailed Analysis Unit (DAU) 44 (Others are reported, but this is the only one that has direct geographic relevance)
State - DWR Bulletin 118-1, May 1981 Vol. IV: South Santa Clara County Area	Geologic description; Geohydrology, incl. Land use and pumpage; unit values of applied water for seven crop types; deep percolation (in ac-ft) for the seven crop types in pervious and impervious soils	1964-65 through 1972-73, by water year	Land-use surveys 1967 & 1974; Land use for 1964-67 assumed similar to 1967; for 1967-70, & 1970-75, based on surveys, 1970 "Atlas..."(USGS publ.), & interpolation. Land-use: ag, urban, native veg. acres by water yr.; Pumpage: Ag, urban Ac-ft by water yr. Ag pumpage from land-use data & estim'd unit applied water (see p. 105); Urban pumpage by distrib among urban areas in nodes, deliv's by Gilroy & M.H., then annual use per node.		"South Santa Clara Valley," extends from Coyote Narrows in the north to Hollister (San Benito Cnty) in the south	Try to segregate So County qtys from S. Benito Cnty; reevaluate data with updated water use coefficients if needed

Data Source	Data Type	Years Included	Data Derivation	Type of Data Breakdown	Geographic Breakdown	Use
State - SWRCB, Div of Water Rights	Surface water diversions from streams; possibly as much as several thousand acre-feet per year of diversion and use for irrigation, stockwatering, domestic purposes	Beginning cal. year 1966 to present for Statements of Diversion; from 1914 to present for appropriative right holders	Initial and triennial Statements of Diversion submitted by diverters as req'd by Water Code; Also Triennial Reports of Licensee & annual reports by permittee by all appropriative water rights holders	By individual diversion facility in gallons or ac-ft; some diverters report monthly qtys, others just annual qtys; incentive exists to report more than actual use to maintain the right	Diversion data available on floppy disk, possibly may sort by TRS location	Source of unique reports on water use; may contrib. to mtg consum. use req'mts; qtys may not be signif. in Zone W-5 alone; more diversion in hills
Jorgensen & Solomon report (undated, but presented to SCVWD Board as agenda item on 3/3/92)	Evapotranspiration data; Proposed Crop Factors	Provided for "Normal Year" average for each month	Fresno State - Center for Irrigation Technology; various publications & expertise in irrig. technology	Evapotranspiration data from 3 weather stations in the Santa Clara County	Gilroy, Los Gatos, & San Jose weather stations operated by DWR for CIMIS	Possibly useful for comparison w/ crop factors used in previous reports
Federal - USGS, Water Resources Division	Groundwater Pumpage	(uncertain)	PG&E Pump efficiency tests on wells; PG&E power consumption records; resulting coefficients developed for kwh per ac-ft of water pumped	USGS has signed confidentiality agreement with PG&E (and other public utility companies) such that "...raw data are classified as confidential and data from individual accounts may not be identified. Estimates of pumpage may be released to the public for areas no smaller than 36 mi^2." Bill Templin, at USGS, is compiling a database that will provide pumpage qtys broken down by ¼-township. Pump efficiency test reports do not identify the wells by state well ID number; however, USGS has capability to cross reference with a GIS.		Usefulness & accessibility not yet determined. Our area of interest is located within about eight townships, for which the boundaries do not coincide with the WSAs of interest.

Determining south county historical water use during the period 1967 to 1987 will require the evaluation and manipulation of existing data, other than direct measurement records, for that time period. There exist no direct measurement records of groundwater pumpage in the south county other than for the wells owned and operated by the cities of Morgan Hill and Gilroy which supply water to customers in their respective service areas. (Other minor water retailers exist that may be able to provide some useful data.)

The task of determining the water use in that period will therefore require some degree of estimating water use after applying two indirect measurement methods. The first method is based on land use and water required for the particular use. The second method is based on power consumption (in kilowatt-hours) as a function of the amount of water pumped from wells. The following publications provide information that will be useful in varying degrees.

Previous Related Reports, Studies, and Other Work

Ludorff & Scalmanini, Consulting Engineers. (March 1986)
ANNUAL INVESTIGATION AND REPORT OF GROUND-WATER CONDITIONS 1984-1985, GAVILAN WATER CONSERVATION DISTRICT. This report was "...prepared in conformance with Sections 75560 and 75561 of the Water Conservation District Law of 1931, which requires that the District shall annually investigate and report on groundwater conditions within the District." The Gavilan Water District in 1984 developed and implemented a ground-water monitoring program to comply with the referenced act of 1931. The report focuses more on groundwater levels and monitoring of those levels, but it also presents some general groundwater pumpage quantities, evidently just for ". . . comparative purposes. . ." from 1977 to 1985. It should be noted that any data generated from or about the Gavilan Water District would be in the context of the geographic boundaries of that district, which coincide more closely with SCVWD's Zone W-6, for which the northern boundary is Tennant Avenue in Morgan Hill. This boundary is in contrast to the northern boundary of Zone W-5, which is nearly ten miles further northwest and more closely coincides with Metcalf Road at Coyote Narrows. Other work was conducted and presented by Luhdorff & Scalmanini, but more focus seemed to be on water quality, as nitrate content in soils was drawing considerable attention.

U.S Geological Survey. Jonathan Diamond and Alex K. Williamson. (October 1983).
A SUMMARY OF GROUND-WATER PUMPAGE IN THE CENTRAL VALLEY, CALIFORNIA, 1961-77 (Water-Resources Investigations Report 83-4037); Sacramento, California. This report was recommended by Bill Templin at the USGS Water Resources Division in Sacramento. It presents the results and accuracy of estimates from applying the power consumption method for determining agricultural groundwater pumpage for the years studied. It also explains the method of estimation by consumptive use; however, this method was not used for the report which states that a disadvantage of the method is ". . . that it has no direct connection with the quantity of pumpage and instead relies on estimates of factors which affect groundwater pumpage."

Department of Water Resources in cooperation with Santa Clara Valley Water District. (May 1981)
Evaluation of Groundwater Resources South San Francisco Bay, Volume IV: South Santa Clara County Area (Bulletin 118-1). Sacramento, California.
This report ". . . presents the geohydrologic conditions that affect the occurrence and movement of ground water in South Santa Clara Valley and a contiguous portion of Hollister Basin in San Benito County. . . The geohydrologic study . . . was performed to provide a framework for the development of a mathematical model of the ground water basin. . . The ground water model for South Santa Clara Valley is verified as well as available data will permit."

The period of study was from 1964 through 1973, and the study made use of land-use surveys that were available for 1967 and 1974. It appears to be the most comprehensive analysis of the south county contained in one source or volume. Additional work would be required to separated out pumpage in San Benito County from that in South Santa Clara County.

Santa Clara Valley Water District. Anne R. Hartman, Barbara Judd. (June 1993)
Water Needs Study.
This report presents future water needs projections based, in part, on information ". . . drawn from extensive analysis of historic water use in the County and future projections of demographic data." However, information gathered to estimate base year South County agricultural use may be helpful in estimating water use in other historical years. The methods for relating water use and demographic data used to forecast future M&I use may be helpful in estimating past M&I use.

Santa Clara County Planning Department. (September 1974)
South County Summary & Adopted Policy "The purpose of this paper is to summarize the background papers developed during the South County Planning Program as well as report on some subsequent actions and policies adopted by the South County Planning Committee in May of 1974."

The **South County Planning Program** was undertaken beginning in June 1972 and resulted in this report. About 15 background papers were prepared that addressed the various issues (e.g., agriculture, housing, transportation, flood control, employment, gov't structure, etc.) considered in the policy/planning objectives. Much of the information compiled in the background papers was drawn from the 1970 census (the numbers were not reduced accordingly when the revised 1970 data for population and dwelling units for the five tracts were reduced by about ten percent, as published and received in April 1973). The report's discussion of agriculture generally addresses the entire County. Some statistics are referenced, e.g., "Nineteen seventy-one statistics on agricultural acreage in Santa Clara County . . . indicate that 48 percent of the total trees and vines still are located north of Coyote." (p. 3)

The background paper on water resources was prepared by the SCCFC&WD, dated Dec. 1972, which summarizes information drawn from SCCFC&WD's South Santa Clara County Water Planning Study Final Report, August 1972. Whereas the District's larger study addressed the Almaden, Edenvale, Coyote, and other South County planning areas, the shorter, summary version addresses only the Morgan Hill, San Martin, and Gilroy areas.

The Water Resources in South County background paper provides the following data considered existing in 1970: land use (residential, commercial, or industrial) by planning area and acreage; population by planning area; total water demands in acre-feet by planning area, "Current Extractions. ." from the Llagas groundwater basin in the planning areas, and other related incidental quantities offered in the narrative text. The information may offer some "reasonableness" checks against other data.

Santa Clara County Flood Control and Water District. (August 1972). Victor Graveto, T.B. Pandit, T. Iwamura
South Santa Clara County Water Planning Study Final Report. (Vols. 1 & 2)
The study ". . . was initiated and undertaken jointly by the County of Santa Clara and the Santa Clara County Flood Control and Water District through an agreement dated September 11, 1968." "The objectives ... were to evaluate the present and future water resources and water requirements of the South County Planning Area." The area studied extended from Hillsdale Avenue in San Jose south to the Pajaro River. In relevance to this current water use study, the (SCCFC&WD) study involved collecting information on population and land use, determining unit water demand factors, and finding total water demands by applying the unit values to land use acreages. In 1969, the County

Planning Department completed a transportation study for which a population model had been developed, based on detailed analysis of the County's growth in the period 1960-65. The (SCCFC&WD) study assumed that in the Coyote, Morgan Hill, San Martin, and Gilroy areas, 100% of agricultural areas under orchard and field crops were and would be, for forecasting purposes, irrigated (p. 2-17). Also, 1970 is the first year for which the study presents acreages and water use related data. Therefore, the information presented for that year was from projected data, not actually recorded or based on existing conditions. Unit water demand factors are presented for agricultural, commercial, industrial, and residential/indoor and residential/outdoor sectors (p. 2-18). A separate agricultural unit water demand factor was developed for each planning area of the study based on (1) acreage data in DWR's 1967 land use survey and (2) crop factors developed and used by the District for the assessment of groundwater charges (instructions and worksheets for groundwater statements, January 1970). The resulting crop factors used were as follows: Coyote - 1.57, Morgan Hill - 1.30, San Martin - 1.55, and Gilroy - 1.90 (units are ac-ft/acre/year). Other projected 1970 quantities presented in the study are (1) total water demands by planning area (p. 2-26); (2) total urban land use broken down into residential, commercial, and industrial, for each planning area (p. A-5); (3) irrigated acreages broken down by planning area (p. 2-19); and population (p. 2-13). A sample calculation using the above information to determine a resid-comm-indust and ag breakdown of water use for Morgan Hill, 1970, shows the numbers check and total the reported water demand. Any attempt to determine usage for other years from this study would be subject to the various unknowns inherent in the computer model and forecasting process. This study may be of benefit for information other than projected values or quantities.

Santa Clara Valley Water District. (December 1975). H. Majumdar, M. Gomez, W. Hoeft, T. McGarry
MASTER PLAN FOR EXPANSION OF THE IN-COUNTY WATER DISTRIBUTION SYSTEM.
This report presents projected water needs and alternatives studied that may be considered to meet those needs. Projections are broken down by groundwater basin and by M&I and Ag water demands for the decade years 1980 to 2020. The text of the report states that "...irrigated acreages in the year 1970 in the Coyote and Llagas Basins were obtained using information from the 1965 land use survey of the County, the 1967 land use survey of the Department of Water Resources and the increase in urban land between 1965 and 1970." (p. I-17). However, no 1970 irrigated acreage data is found in the report. The Appendix volume, on the other hand, presents "Agricultural Acreages Irrigated As of 1970" (p. A-10) for the subareas Coyote, Morgan Hill, San Martin, Gilroy, and Llagas-Uvas, based on "the County Planning Department's data on Agricultural Acreages in the South County (1965)." (p. A-7)

Santa Clara Valley Water District. (May 1983). W. Molnar, J.A. Micko, D. Chesterman, L. Barker, T. Iwamura, J. Line
South Santa Clara County Water Supply Plan.
"This report is an update of the section from the Master Plan that deals with South Santa Clara County. This report evaluates various alternatives for providing an adequate water supply to the South Santa Clara valley and recommends one alternative for implementation." The first year of projected data is for 1985 and broken down into M&I, Ag, and Total "Projected Annual Average Water Needs..." for each water service area. This report appears to have little, if any, usable data. The report assumes a 1975 base year estimated total water use of 84,000 acre-feet; 10,800 from the Coyote Subbasin and 73,800 from the Llagas Subbasin (p. 6). The report itself presents no discussion on that quantity of use nor the quantity's derivation. However, the Appendix volume of the report presents (p. B-10) a "Basin Balance" for the Llagas basin, in which "GW Pumping" values are derived for years 1975-76 and 1979-80. The report's predominant focus appears to be on the hydrodynamics of the Llagas groundwater basin, anticipated land use conversions, assessment of projected future South County water supplies, and proposed management of those supplies.

Department of Water Resources. (April 1986).
Crop Water Use in California. (Bulletin 113-4). Sacramento, California
This appears to be a primary source document for the development of evapotranspiration and applied water use factors. This is reportedly the source of Figure D-1 in the District's Water Needs Study, June 1993. However, neither the data table nor similar compilation of data could be found in this (113-4) report. A compilation by county does appear (p. 20), but that information is footnoted as being based on DWR Bulletin 160-83, The California Water Plan - Projected Use and Available Water Supplies to 2010, December 1983. The report presents in Appendix H "Average Measured Irrigation Deliveries," or Crop Applied Water Data, for selected Detailed Analysis Units (DAUs) in most of the Hydrologic Study Areas (HSAs) of the state. DAU 44, in the San Francisco HSA, which covers all of North Santa Clara County and part of South County, is one of the DAUs included in the report. (The remaining portion of South County, DAU 62, is not included.)

Department of Water Resources. (March 1968).
Land Use Survey - 1967, Santa Clara County
This is the source of irrigated acreage data used in the District's August 1972 South County study. The results of the survey have been requested of the Department. The request was reiterated by District library staff on Monday, Feb. 7th. Bob Teeter at the District library spoke with Ed Morris at DWR who said John Mueller had already requested the information for the District, that it would take several days to assemble the materials and send them to the District. (The materials will hopefully arrive within the next week.) Land Use Surveys of Santa Clara County were also conducted in 1977 and 1987-90, and one for 1974 has been mentioned in another publication; some of the 1987-90 survey result were obtained by Derek MacKay (temporary District employee) in May of 1992. That information will be used. Results of the 1977 survey will also be requested and used.

Department of Water Resources. (December 1983).
The California Water Plan - Projected Use and Available Water Supplies to 2010, (Bulletin 160-83). Sacramento, Calif. This is the fourth major update of the state's 1957 California Water Plan; previous updates were in 1966, 1970, and 1974. It is ". . . designed to present the overall outlook for water supply needs throughout the State and to assess the availability of water supplies to satisfy these needs.. . . This update compares water use and water supplies . . . As such, it is more of a 'user's manual' than previous editions have been. . . . Most of the findings and conclusions presented . . . are summarized by Hydrologic Study Area (HSA)." There are 12 HSAs in the State. Unfortunately, part of Santa Clara County is in the San Francisco Bay HSA, and the other part is in the Central Coast HSA, with the boundary between the two occurring near Cochrane Road. The report states that irrigation in Santa Clara County is intense and therefore relatively high, at about 80% (pp. 94, 99). Other data that may be relevant is of very low precision and very general, therefore of limited use.

DRAFT Bulletin 160-93, copies of which have circulated about the District, presents more detailed information on methods used in determining agricultural water use. Specific data, however, such as crop unit evapotranspiration of applied water (ETAW), in acre-feet/acre per year, although provided for major crop types, is only broken down geographically by HSA. The draft includes a sidebar on the Department's "Land Use Survey Program." The draft also cautions: "Bulletin 160 forecasts of agricultural acreage begin with a determination of a base year level of development. This base acreage normally differs from the actual acreage irrigated in the base year. This is particularly evident in this Bulletin because the base year of 1990 was a drought year. . . . Agricultural acreage data for the 1980s were developed from DWR land use surveys and crop statistics developed by the Department of Food and Agriculture. Actual acreage values for 1990 were adjusted, based on averages of the 1980s, to reflect more normal year water supply and market conditions, the resulting base year values are termed '1990 normalized.'" (p. 194). The value in this bulletin would be in attaining understanding of the development of ETAWs and their use.

Vince Stephens, SCVWD, in 1991 developed estimates of South County historical water use in order to estimate natural groundwater yield for South County. He performed his analysis for years 1967 to present. He computed historical water by using acreages by crop and crop factors for each crop grown in South County. The crop acreages in So Cnty were estimated by subtracting north county acreages reported to Water Revenue from the totals shown on the County Crop Reports, for which only total countywide acreages are available. That method does not allow for constraining the study area to Zone W-5, and may include North County crops outside of Zone W-2. Crop factors for each crop were developed by dividing reported water production in No Cnty by the crop's reported acreage; the result was the crop factor used for that crop for that year in So Cnty. If no No Cnty data was available for a particular crop, then Water Revenue's crop factor was used. Groundwater pumping in So Cnty was then calculated for each year by totaling the agricultural quantities and the municipal quantities reported by Morgan Hill and Gilroy. No provisions were made for rural domestic pumping or surface water diversion and use.

Pam Halton, SCVWD, in July 1974 prepared a report on South County agricultural productivity in response to a Bureau of Reclamation inquiry and the Bureau's need for certification and classification of agricultural lands to be served by San Felipe project water. The letter of request from the Bureau was dated July 8, 1974, and Pam's worksheets show notations by a typist indicating typing was completed July 25, 1974. So the project appears to have been initiated and completed within a few weeks. Pam's work was a compilation of data obtained from the County Planning Department's "INFO" publication and the County Agricultural Commissioner's annual crop reports. Her work presents no new information. Included in the folder containing her worksheets is a copy of the report "SANTA CLARA COUNTY AGRICULTURE - A LOOK AT ITS FUTURE, June 1972, Peter J. Lert, Agricultural Extension, University of California, Santa Clara County. The text of the report contains the following information which may prove useful:

> "During the five years from 1964 to 1969, the average annual conversion of farmland to urban uses was 4400 acres. It is to be anticipated that this rate will decline in the future. On the other hand, during 1971 more than 6000 acres of bearing orchards were removed, of which slightly less than 2000 acres were for urban uses, with more than 4000 acres removed because of unfavorable economic conditions for the tree crops involved.
>
> "Nineteen seventy-one statistics on agricultural acreage in Santa Clara County provided by the Agricultural Commissioner, indicate that 48 per cent of the total trees and vines still are located North of Coyote. This is a surprising figure considering the recent rate of urbanization. In terms of major crops, the 15,000 acres of trees in North County include 85 per cent of the County's apricots, 62 per cent of the cherries, 66 per cent of the pears, on-half of the walnuts, and 40 percent of the grapes. (p. 3)

(The above report was also served as the background paper on the county's agriculture for the **South County Planning Program** mentioned above (South County Summary & Adopted Policy, September 1974.)

Appendix B. Crop Groups

Major Group	**DWR Classes**	**County Crop Report Crops**
Fruit/nut trees	Deciduous fruits and nuts (D), kiwi (C8)	Apples, apricots, cherries, peaches, pears, plums, prunes, walnuts, kiwi, misc. fruits and nuts
Grapes	Vineyards (V)	Grapes
Corn	Corn (F6)	Corn
Cucumber/ Squash/Melons	Melons, squash and cucumbers (all types) (T9)	Cucumbers, squash/gourds, pumpkins
Garlic	Onions and garlic (T10)	Garlic
Peppers	Peppers (chili, bell, etc) (T21)	Peppers bell, peppers wax & chili
Tomatoes	Tomatoes (T15)	Tomatoes fresh, tomatoes processed, tomatoes cherry
Other vegetables/ truck crops	all other Truck crops (T)	all other Vegetable crops, bushberries, strawberries
Hay-alfalfa	Alfalfa and alfalfa mixtures (P1)	Hay alfalfa
Other grains/hay	Grain and hay crops (G)	Barley, oats, wheat, hay grain, hay other
Sugar beets	Sugar beets (F5)	Sugar beets
Irrigated pasture	Native pasture, mixed pasture (P3, P4, P5)	Pasture-irrigated
Other field crops	all other Field crops (F)	Safflower, beans, misc. field crops, seed crops
Flowers	Flowers and nursery (T16)	Nursery crops, floral crops

Appendix C. DWR Land Use Survey Maps

The base maps used in DWR's land use surveys are USGS 7½-minute 1:24,000 scale quadrangle maps. DWR Land Use Survey maps for Santa Clara County are numbered 1 through 34 (lower right corner of sheet and circled). They are also numbered according to a grid location (by row no. and column no.) which is the reference "Quad Number" shown on the surveys' tabulated data sheets, far left column. The whole of Santa Clara County occupies rows 37 through 41 (north to south), and columns 19 through 27 (west to east). The SCVWD uses county maps with a slightly different map sheet numbering system. For the south county, the relevant maps are:

DWR Sheet Number	Quad Number (Grid ID)	USGS 7½' Quad Name	SCVWD Sheet Number
17	3922	Santa Teresa Hills	22
18	3923	Morgan Hill	23
19	3924	Mt. Sizer	24
25	4023	Mt. Madonna	32
26	4024	Gilroy	33
27	4025	Gilroy Hot Springs	34
31	4124	Chittendon	40
32	4125	San Felipe	41

DWR's 1967 survey geographic breakdown for the county was first by DWR hydrographic units. San Francisco Bay Hydrographic Unit is coded 01, and Monterey Bay Hydrographic Unit is coded 02. The approximate north-south boundary between the two units is about 3,600 feet southeast of Cochran Road in Morgan Hill. The next level of subdivision in the survey was by census county divisions, also referred to as "service area." The census county divisions, 020, 022, 023, and 024 and their boundaries *generally* correspond to the water service areas of interest in the project - Coyote, Morgan Hill, San Martin, and Gilroy, respectively.

The land use survey data for 1967 is presented in tabulated form by geographic breakdown, and the sections of data are by:

1) county totals
2) service area subtotals
3) hydrographic unit totals by service area subtotals
4) quad map totals by service area and hydrographic unit subtotals
5) hydrographic unit totals

It is important to note that the hydrographic unit boundary southeast of Cochran Road is not coterminous with the boundary between the Coyote and the adjacent Morgan Hill census divisions. Hence, part of the Coyote division overlaps into the Monterey Bay Hydrographic

Unit. The geographic breakdowns of tabulated data (for the 1967 survey) facilitated the process of transferring the crop data to a LOTUS spreadsheet and grouping crop acreages by District WSA.

For the 1977-78 land use survey, DWR used another geographic breakdown, the Detailed Analysis Unit (DAU). DAUs are subareas of hydrographic units and are typically defined by watershed boundaries. Any given DAU is wholly within its larger hydrographic unit. DAU 44, which is in the San Francisco Bay Hydrographic Unit (01), comprises most of Santa Clara County, and extends southward to include all of the District's Coyote WSA. DAUs 61, 62, and 63, which include the remaining southern part of the county and extend into San Benito County, are in the Monterey Bay Hydrographic Unit (02). Unit 01 is within DWR's Central District, and Unit 02 is in DWR's Southern District. Of interest, then are DAUs 44, 61, 62, and 63, but because of DWR's district responsibilities and schedules, DAU 44 was surveyed in 1977 and DAUs 61, 62, and 63 were surveyed in 1978. Results of the two surveys were combined into the Santa Clara County Land Use Survey of 1977 and 1978.

The land use survey data for 1977-78 is presented similarly to that of the 1967 survey, and the sections of data are by:

1) county totals
2) DAU totals
3) quad map totals by service area (census county division) subtotals and DAU subtotals

The 1977-78 survey also used census divisions which generally corresponded to District WSAs, so compilation onto a LOTUS spreadsheet for our use was relatively simple.

1990 Land Use Survey---
DWR did not use census division boundaries in their 1990 survey. The tabulated sections of data are by:

1) county totals
2) quad map totals by DAU and hydrographic unit subtotals
3) DAU totals
4) hydrographic unit totals
5) quad map totals and hydrographic unit subtotals

Data from the 1990 survey had to be transferred to a LOTUS spreadsheet and broken down by District WSA without the advantage of the lowest geographic level being census tract. It was therefore necessary to transfer WSA boundaries by computer graphics onto copies of the DWR survey base maps (USGS quad sheets). The lowest geographic level of delineation for the DWR survey was the DAU, and the lowest for USGS was the quad map sheet. In many areas the WSA boundaries at the valley floor perimeter were coterminous with land use boundaries between native vegetation (not irrigated and not pertinent to the study) and irrigated crops.

Of the eight map sheets relevant to the study, five showed enough correlation between land use classification and WSA boundary to facilitate tabulation of crop type and subsequent assignment to the appropriate WSA. The other three map sheets, however, required additional compilation techniques to properly assign and tabulate classifications with their appropriate WSAs. Planimetering small areas by land use classification on two of the quad sheets gave sufficient information to assign crop types to their appropriate WSAs and help ensure full coverage of the respective WSAs. However, determining acreages in WSAs on the remaining quad sheet, 40-24 (row-column ref.) was impractical and too error prone for the planimetering method, as most of the sheet showed a high concentration of irrigated crops of various crop types, shapes, and sizes in numerous parcels. The quad sheet contains areas of three different WSAs, but is generally split north-south between the San Martin WSA in the north and the Gilroy WSA in the south. A small part of the Morgan Hill WSA occupies the northwest corner of the quad sheet.

The method used to count acreage by crop type and assign to WSA was DWR's method of cutting and weighing the parcels grouped by crop type. This procedure was performed under laboratory conditions at the Rinconada Water Treatment Plant using an electronic balance capable of weighing small masses to the nearest tenth of a milligram. Using the known total acreage covered by the quad sheet, several weighings of the total sheet screage within the borders, and subsequent weighings of increasingly smaller pieces for checking purposes, a factor of 1.95 Acres per milligram of paper was determined. Subsequent cutting and weighing yielded the acreages of irrigated crops for their respective WSAs with favorable precision.

Appendix D

Summary of crop acreage by DWR Land Use Survey - 1967

CROP TYPE	COYOTE Acreages	MORGNH Acreages	SMARTN Acreages	GILROY Acreages	South County Acreages	County Totals
G - Grain & Hay	0	0	0	0	0	
D - Fruits & Nuts	9	0	0	0	9	702
V - Vineyards	73	228	584	972	1,857	2,703
F - Field Crops	0	0	0	0	0	
T - Truck & Berry	0	0	0	0	0	175
P - Pasture	0	0	0	0	0	
G3 - Oats	0	0	0	0	0	
G6 - Misc.	0	0	0	0	0	32
F1 - Cotton	0	0	0	0	0	
F2 - Safflower	0	0	0	0	0	
F4 - Hops	0	0	0	0	0	
F5 - Sugar beets	0	0	0	244	244	285
F6 - Corn (field or sweet)	0	0	119	511	630	699
F7 - Grain sorghums	0	0	0	176	176	176
F8 - Sudan						
F10 - Beans						
P1 - Alfalfa & alfalfa mix.	45	0	102	211	358	464
P2 - Clover	0	0	0	0	0	
P3 - Mixed pasture	275	364	1,289	509	2,437	3,403
P4 - Native pasture						
P5 - Induced native pasture						
P7 - Turf farms						
T1 - Artichokes						
T2 - Asparagus	0	0	0	0	0	4
T3 - Beans (green)	0	0	0	1,074	1,074	1,331
T4 - Cole crops	8	0	0	101	109	363
T6 - Carrots	0	0	0	0	0	24
T8 - Lettuce (all types)	0	0	13	5	18	106
T9 - Melns, sqush, cuc.	20	5	383	749	1,157	1,384
T10 - Onions and garlic	0	0	0	509	509	764
T11 - Peas	0	0	0	0	0	
T15 - Tomatoes	450	25	155	4,238	4,868	9,115
T16 -Flowers and nursery	13	11	24	64	112	697
T18 - Misc. truck	66	173	356	230	825	3,656
T19 - Bushberries	0	0	19	0	19	33
T20 - Strawberries	0	10	44	89	143	206
T21 - Pepprs(chili, bell, etc.)	166	0	16	1,098	1,280	1,364
T22 - Broccoli	0	0	0	0	0	
D1 - Apples	0	0	8	33	41	437
D2 - Apricots	49	234	106	254	643	2,987
D3 - Cherries	12	52	92	523	679	782
D5 - Peaches & nectarines	0	0	0	0	0	33
D6 - Pears	246	0	347	748	1,341	5,084
D7 - Plums	0	0	14	37	51	85
D8 - Prunes	3,587	2,653	4,554	5,160	15,954	28,522
D9 - Figs	0	0	0	0	0	11
D10 - Misc. deciduous	0	17	0	46	63	6,786
D12 - Almonds	0	0	0	0	0	11
D13 - Walnuts	114	897	731	493	2,235	4,117
C6 - Olives	0	0	0	0	0	20
C7 - Misc. subtropical fruits	0	0	0	0	0	
C8 - Kiwis	0	0	0	0	0	
S4 - Lawn areas (semi-ag)	140	0	15	131	286	2,517
S5 - Cemetaries (semi-ag)	0	0	0	0	0	
TOTAL ACRES:	5,273	4,669	8,971	18,205	37,118	79,078

Note: includes lands not included in agr. water use estimate

Summary of crop acreage by DWR Land Use Survey - 1977

CROP TYPE	COYOTE Acreages	MORGNH Acreages	SMARTN Acreages	GILROY Acreages	South County Acreages	County Totals
G - Grain & Hay	1,302	236	0	611	2,149	3,617
D - Fruits & Nuts	227	35	33	7	302	5,305
V - Vineyards	111	129	434	546	1,220	1,772
F - Field Crops	0	0	0	0	0	11
T - Truck & Berry	0	0	0	0	0	5,172
P - Pasture	0	0	0	0	0	31
G3 - Oats	0	0	0	0	0	
G6 - Misc.	0	0	0	0	0	
F1 - Cotton	5	0	0	1	6	6
F2 - Safflower	0	0	0	0	0	
F4 - Hops	0	0	0	0	0	
F5 - Sugar beets	34	0	56	383	473	605
F6 - Corn (field or sweet)	30	15	13	67	125	125
F7 - Grain sorghums	0	0	0	0	0	
F8 - Sudan	0	0	0	147	147	147
F10 - Beans	0	0	328	777	1,105	1,105
P1 - Alfalfa & alfalfa mix.	0	0	231	209	440	508
P2 - Clover	0	0	8	0	8	8
P3 - Mixed pasture	134	129	522	318	1,103	1,286
P4 - Native pasture	4	27	245	168	444	650
P5 - Induced native pasture	0	0	0	0	0	
P7 - Turf farms	0	0	0	0	0	
T1 - Artichokes	10	0	0	1	11	11
T2 - Asparagus	0	0	0	222	222	222
T3 - Beans (green)	89	16	0	0	105	105
T4 - Cole crops	0	0	0	0	0	
T6 - Carrots	0	0	8	33	41	41
T8 - Lettuce (all types)	0	0	27	805	832	832
T9 - Melns, sqush, cuc.	64	189	353	919	1,525	1,635
T10 - Onions and garlic	62	0	83	906	1,051	1,051
T11 - Peas	0	0	0	0	0	
T15 - Tomatoes	982	118	387	4,898	6,385	6,593
T16 -Flowers and nursery	58	106	302	179	645	645
T18 - Misc. truck	78	266	580	610	1,534	1,892
T19 - Bushberries	0	3	0	0	3	3
T20 - Strawberries	100	30	138	0	268	268
T21 - Pepprs(chili, bell, etc.)	205	16	253	959	1,433	1,561
T22 - Broccoli	0	0	0	0	0	
D1 - Apples	0	0	7	0	7	7
D2 - Apricots	95	4	0	38	137	147
D3 - Cherries	351	90	146	500	1,087	1,087
D5 - Peaches & nectarines	0	0	0	0	0	
D6 - Pears	29	0	149	114	292	440
D7 - Plums	0	0	0	0	0	
D8 - Prunes	1,066	577	420	900	2,963	3,038
D9 - Figs	0	0	0	0	0	
D10 - Misc. deciduous	0	123	223	348	694	694
D12 - Almonds	0	0	0	0	0	
D13 - Walnuts	127	693	401	423	1,644	1,731
C6 - Olives	0	0	0	0	0	
C7 - Misc. subtropical fruits	0	0	0	0	0	169
C8 - Kiwis	0	0	0	0	0	
S4 - Lawn areas (semi-ag)	334	16	68	94	512	4,580
S5 - Cemetaries (semi-ag)	0	0	0	13	13	264
TOTAL ACRES:	5,497	2,818	5,415	15,196	28,926	47,364

Summary of crop acreage by DWR Land Use Survey - 1990

CROP TYPE	COYOTE Acreages	MORGNH Acreages	SMARTN Acreages	GILROY Acreages	South County Acreages	County Totals
G - Grain & Hay	748	632	757	3,324	5,461	6,382
D - Fruits & Nuts	0	0	4	0	4	28
V - Vineyards	36	68	409	407	920	964
F - Field Crops	0	0	0	0	0	
T - Truck & Berry	0	0	0	0	0	
P - Pasture	0	0	0	0	0	
G3 - Oats	20	84	17	98	219	218
G6 - Misc.	11	0	68	62	141	319
F1 - Cotton						
F2 - Safflower	515	49	24	99	687	687
F4 - Hops	0	0	0	0	0	
F5 - Sugar beets	0	0	93	700	793	793
F6 - Corn (field or sweet)	146	27	206	1,061	1,440	1,662
F7 - Grain sorghums	0	8	0	6	14	14
F8 - Sudan	0	0	28	176	204	213
F10 - Beans	0	0	5	227	232	232
P1 - Alfalfa & alfalfa mix.	3	0	309	122	434	514
P2 - Clover	0	0	0	0	0	
P3 - Mixed pasture	0	6	7	65	78	78
P4 - Native pasture	81	15	605	161	862	955
P5 - Induced native pasture	2	0	11	0	13	13
P7 - Turf farms	129	0	0	0	129	129
T1 - Artichokes	0	0	0	0	0	4
T2 - Asparagus	0	86	1	0	87	87
T3 - Beans (green)	485	0	50	127	662	667
T4 - Cole crops	0	33	0	35	68	73
T6 - Carrots	0	0	0	0	0	
T8 - Lettuce (all types)	22	0	16	0	38	433
T9 - Melns, sqush, cuc.	246	18	236	139	639	946
T10 - Onions and garlic	6	48	37	1,057	1,148	1,159
T11 - Peas	0	0	4	0	4	4
T15 - Tomatoes	3	21	104	2,723	2,851	2,899
T16 -Flowers and nursery	338	171	569	457	1,535	1,638
T18 - Misc. truck	124	30	325	743	1,222	1,528
T19 - Bushberries	0	27	19	6	52	52
T20 - Strawberries	0	41	328	59	428	428
T21 - Pepprs(chili, bell, etc.)	256	84	367	836	1,543	1,738
T22 - Broccoli	0	5	0	0	5	5
D1 - Apples	0	11	21	0	32	92
D2 - Apricots	27	54	0	0	81	81
D3 - Cherries	420	90	44	545	1,099	1,111
D5 - Peaches & nectarines	11	114	4	0	129	160
D6 - Pears	3	0	18	34	55	101
D7 - Plums	0	0	0	0	0	
D8 - Prunes	347	220	96	395	1,058	1,446
D9 - Figs	0	0	0	0	0	
D10 - Misc. deciduous	18	50	38	73	179	492
D12 - Almonds	9	0	0	0	9	9
D13 - Walnuts	27	426	339	251	1,043	1,246
C6 - Olives	0	0	2	0	2	2
C7 - Misc. subtropical fruits	0	0	1	0	1	1
C8 - Kiwis	2	29	9	0	40	40
S4 - Lawn areas (semi-ag)	156	40	161	59	416	3,776
S5 - Cemetaries (semi-ag)	0	0	22	0	22	225
TOTAL ACRES:	4,191	2,487	5,354	14,047	26,079	33,644